metal sales
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Retro-Master™

High Performance Retrofit Roof Systems

Design Manual

The application and detail drawings in this manual are strictly for illustration purposes and may not be applicable to all building designs or product installations. All projects should conform to applicable building codes for that particular area. It is recommended to follow all building regulations and standard industry practices.

Metal Sales Manufacturing Corporation is not responsible for the performance of the framing system if it is not installed in accordance with the suggested instructions referenced in this manual. If there is a conflict between this manual and the Metal Sales approved erection drawings, the approved erection drawings are to take precedence.

Prior to ordering and installing materials, all dimensions should be verified by field measurements.

Metal Sales reserves the right to modify, without notice, any details, recommendations or suggestions. Any questions you may have regarding proper installation of the Retro-Master framing system should be directed to your Metal Sales representative, see page iii.

Oil canning is not a cause for rejection. Oil canning can be described as the amount of waviness found in the flat areas of metal panels. Oil canning is an inherent characteristic of light gauge cold formed metal products, particularly those with broad flat areas. There are many factors which may contribute to oil canning that Metal Sales is not able to control. These factors include: misalignment of the support system, over driving of fasteners used on the panels, stress (whether inherent in the panel or induced), thermal expansion and contraction of the panel, material handling, width, gauge, length, color of panels, and installation. (Reference Metal Construction Association “Oil Canning Position Paper” - Appendix A).

Consult Metal Sales for any additional information not outlined in this manual.

This manual is designed to be utilized as a guide when installing the Retro-Master framing system. It is the responsibility of the erector to ensure the safe installation of this product system.

SAFETY

STUDY APPLICABLE OSHA AND OTHER SAFETY REQUIREMENTS
BEFORE FOLLOWING THESE INSTRUCTIONS.

The installation of metal roof systems is a dangerous procedure and should be supervised by trained knowledgeable erectors. USE EXTREME CARE DURING INSTALLATION. It is not possible for Metal Sales to be aware of all the possible job site situations that could cause an unsafe condition to exist. The erector of the roof system is responsible for reading these instructions and determining the safest way to install the roof system.

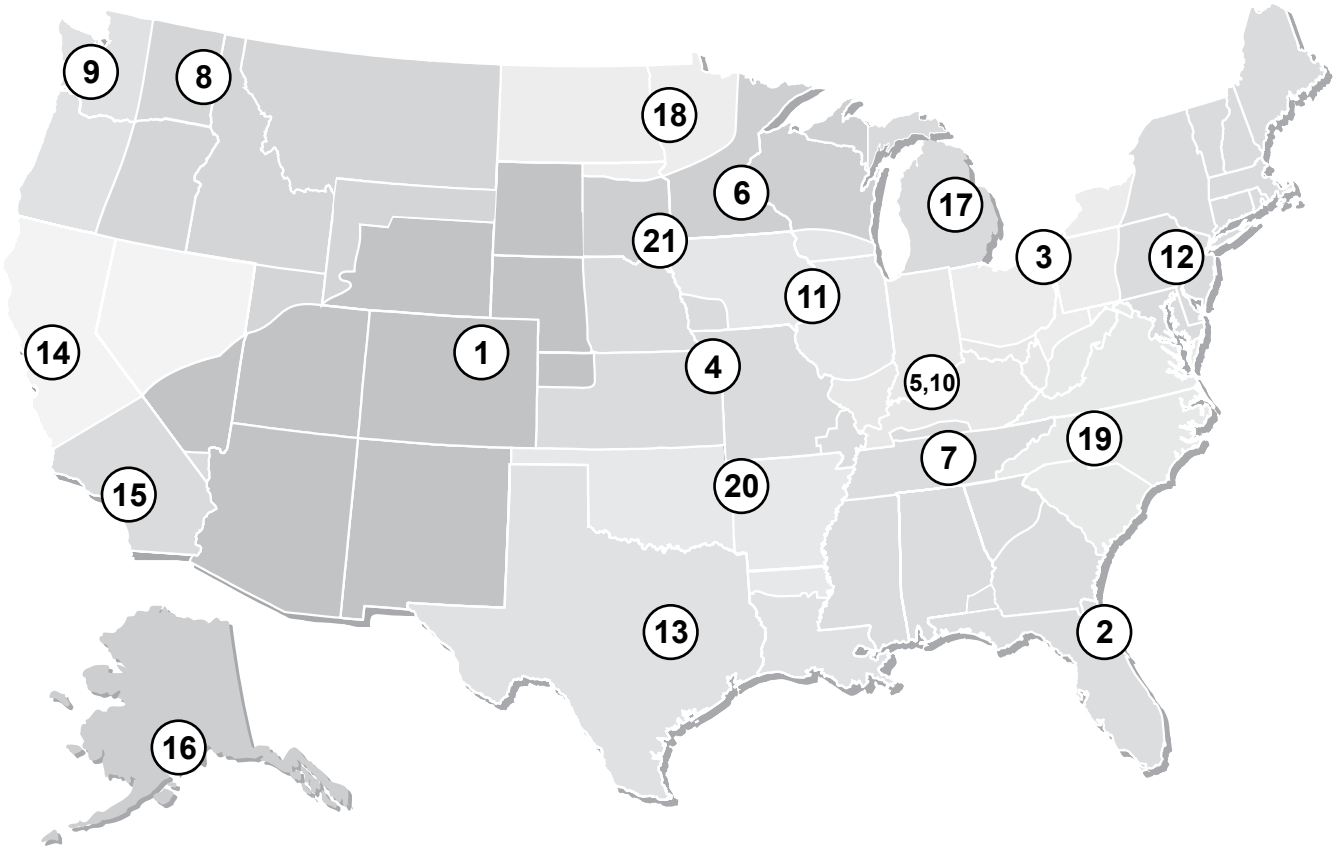
These instructions are provided only as a guide to show a knowledgeable, trained erector the correct parts placement one to another. If following any of the installation steps would endanger a worker, the erector should stop work and decide upon a corrective action.

Provide required safety railing, netting, or safety lines for crew members working on the roof.

Do not use the roof panel as a walking platform. The roof panels will not withstand the weight of a person standing at the edge of the panel.

Do not stand on the roof panel at the ends until the panels have been attached.

Metal Sales Branch Map



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Retro-Master is a re-roof solution that provides every element needed to install a modern, code-compliant, energy-efficient, sloped metal roof over an old or failing roof. Elements include structural framing, subframing and Metal Sales™ roof panels. This retrofit system can be installed over any existing sloped or flat roof and over any existing material such as metal, asphalt, built-up or membrane.

Metal Sales Manufacturing Corporation is the premier nationwide provider of metal panels for the construction industry. Metal Sales works with architectural specifiers and commercial construction professionals to create inspirational design solutions. With the industry's largest and most knowledgeable sales and technical support team, Metal Sales has the expertise to address today's challenges in high-performance, sustainable and Net-Zero building. Celebrating its 50th anniversary in 2013, Metal Sales has outreach around the world, delivering outstanding roof, wall and fascia metal panels from its 21 facilities throughout the U.S. For more information, visit metalsales.us.com.

1.) DENVER BRANCH
7990 E. I-25 Frontage Rd
Longmont, CO 80504
303.702.5440
800.289.7663
800.289.1617 /FAX

2.) JACKSONVILLE BRANCH
7110 Stuart Avenue
Jacksonville, FL 32254
904.783.3660
800.394.4419
904.783.9175 /FAX

3.) JEFFERSON BRANCH
352 East Erie Street
Jefferson, OH 44047
440.576.9070
800.321.5833
440.576.9242 /FAX
800.233.5719 /FAX

4.) INDEPENDENCE BRANCH
1306 S. Powell Road
Independence, MO 64057
816.796.0900
800.747.0012
816.796.0906 /FAX

5.) SELLERSBURG BRANCH
7800 State Road 60
Sellersburg, IN 47172
812.246-1866
800.999.7777
812.246.0893 /FAX
800.477.9318 /FAX

6.) ROGERS BRANCH
22651 Industrial Blvd.
Rogers, MN 55374
763.428.8080
800.328.9316
763.428.8525 /FAX
800.938.9119 /FAX

7.) NASHVILLE BRANCH
4314 Hurricane Creek Blvd.
Antioch, TN 37013
615.641.7100
800.251.8508
615.641.7118 /FAX

8.) SPOKANE BRANCH
East 2727 Trent Avenue
Spokane, WA 99202
509.536.6000
800.572.6565
509.534.4427 /FAX

9.) SEATTLE BRANCH
20213 84th Avenue, South
Kent, WA 98032
253.872.5750
800.431.3470 (outside WA)
800.742.7900 (inside WA)
253.872.2008 /FAX

10.) NEW ALBANY BRANCH
999 Park Place
New Albany, IN 47150
812.944.2733
812.944.1418 /FAX

11.) ROCK ISLAND BRANCH
8111 West 29th Street
Rock Island, IL 61201
309.787.1200
800.747.1206
309.787.1833 /FAX

12.) DEER LAKE BRANCH
29 Pinedale Industrial Rd
Orwigsburg, PA 17961
570.366.2020
800.544.2577
570.366.1648 /FAX
800.544.2574 /FAX

13.) TEMPLE BRANCH
3838 North General Bruce Dr.
Temple, TX 76501
254.791.6650
800.543.4415
254.791.6655 /FAX
800.543.4473 /FAX

14.) WOODLAND BRANCH
1326 Paddock Place
Woodland, CA 95776
530.668.5690
800.759.6019
530.668.0901 /FAX

15.) FONTANA BRANCH
14213 Whittram Avenue
Fontana, CA 92335
909.829.8618
800.782.7953
909.829.9083 /FAX

16.) ANCHORAGE BRANCH
4637 Old Seward Hwy.
Anchorage, AK 99503
866) 640.7663
907) 646.7663
907) 646.7664 /FAX

17.) BAY CITY BRANCH
5209 Mackinaw Rd.
Bay City, MI 48706
989.686.5879
888.777.7640
989.686.5870 /FAX
888.777.0112 /FAX

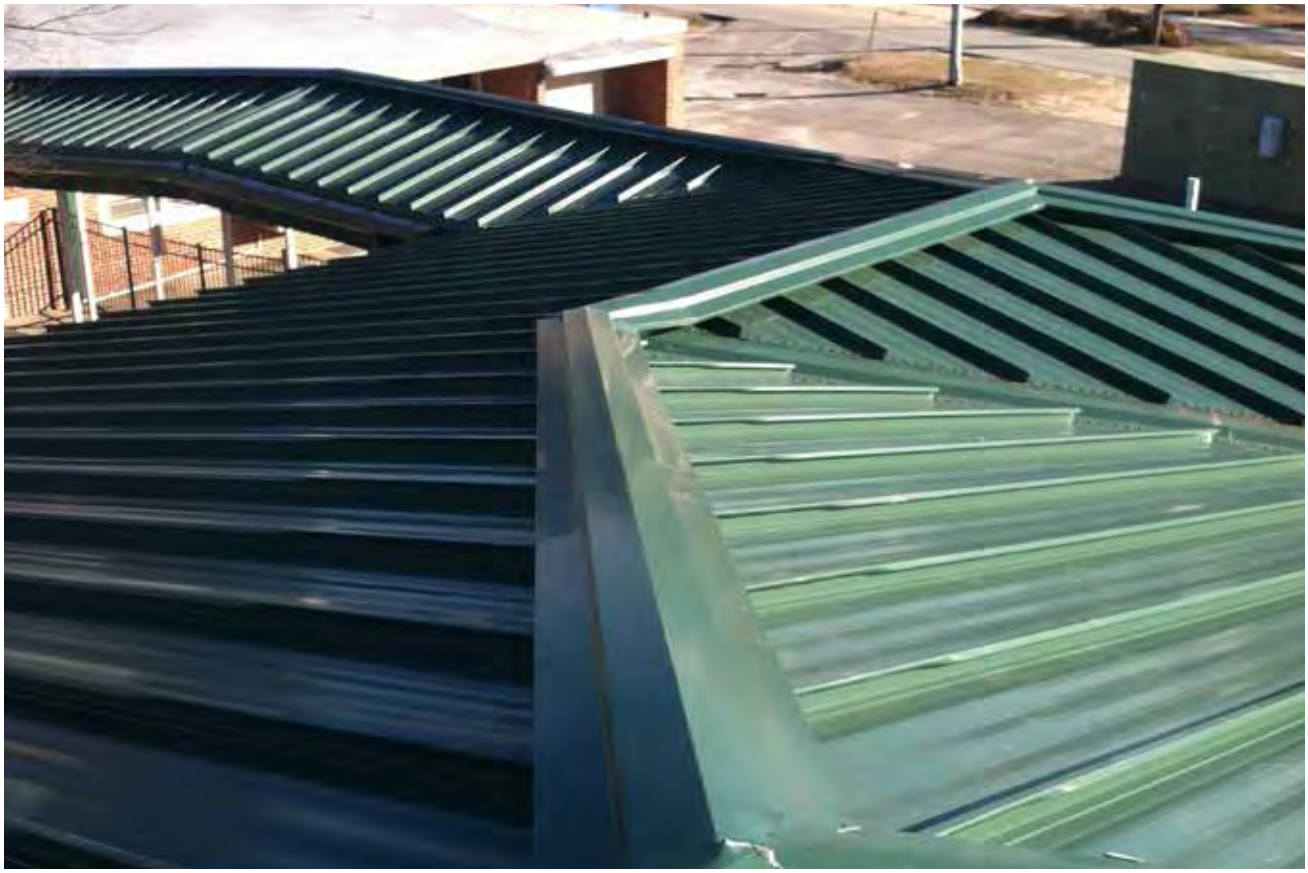
18.) DETROIT LAKES BRANCH
1435 Egret Avenue
Detroit Lakes, MN 56501
218.847.2988
888.594.1394
218.847.4835 /FAX
888.594.4835 /FAX

19.) MOCKSVILLE BRANCH
188 Quality Drive
Mocksville, NC 27028
336.751.6381 Phone
800.228.6119 Toll Free
336.751.6301 Fax
800.228.7916 Toll Free Fax

20.) FORT SMITH BRANCH
7510 Ball Road
Fort Smith, AR 72908
479.646.1176 Phone
877.452.3915 Toll Free
479.646.5204 Fax

21.) SIOUX FALLS BRANCH
2700 West Third Street, Suite 4
Sioux Falls, SD 57104
605.335.2745 Phone
888.902.8320 Toll Free

TECHNICAL SERVICES
545 South 3rd Street, Suite 200
Louisville, KY 40202
502.855.4300 Phone
800.406.7387 Toll Free
502.855.4290 /FAX



Retro-Master™

Corporate Office
545 South 3rd Street – Suite 200
Louisville, Kentucky 40202
800.406.7387 ▪ metalsales.us.com

1 - Introduction

Since our first Retro-Master™ product offering in the early 1990's, Metal Sales™ has been recognized as a leader in the retrofit roofing market. Metal Sales is proud to have engineered and delivered many successful retrofit projects, large and small, throughout the United States. Many have been part of a building beautification project, while others were functional fixes to correct existing roof issues.

The early retrofit systems were assembled using very basic metal framing components. These included roll formed zee-shaped purlins, cee-shaped vertical members, press-broke base members and other miscellaneous shapes. All framing was then rigidly braced to stabilize it to receive the metal roof and wall panels. Retrofit framing today has not changed much from the older systems. Comparing them to the systems in the market today, they differ in how they are braced. The earlier framing systems were laterally braced with strapping that originated from scrapped roofing coil. Often, so much bracing was in place that it was difficult to navigate through the framing during installation.

Metal Sales expertly applies engineering using standard structural members to minimize strapping in the Retro-Master framing systems. As the amount of bracing is a direct result of the specified design wind uplift and snow loading, the Retro-Master solution can reduce contractors' labor cost without sacrificing safety in design. This is just one reason why contractors prefer Retro-Master over other systems.

Retro-Master retrofit systems offer a variety of roof replacement solutions from low slope to steep slope applications for commercial, architectural, institutional and industrial buildings. Our systems are designed for what is termed in the metal construction industry as Metal-over-Flat and Metal-over-Sloped roof applications. They incorporate the existing roof structure, yet allow the addition of roof slope to complete the new installation with a more functional, maintenance-free metal roof system. Retro-Master system components include an extensive line of secondary steel framing in standard shapes that range from cees to zees and a new direct fastened or structural standing metal roof and metal walls. All materials are exclusively manufactured in a nationwide network of Metal Sales facilities.

Photo 1 – Retro-Master framing system under construction

The building owner's real value of a Retro-Master retrofit system is the unparalleled roof service life from the variety of Metal Sales roofing profiles that have proven the test of time with finish and performance warranties to match. The value to the contractor is the confidence of an engineered retrofit package furnished by a nationwide manufacturer that focuses on cost effectiveness, customer service and expeditious delivery.

This manual is designed to provide basic information about retrofitting existing buildings. The manual will explain how projects are engineered, how they are installed and most importantly how they can resolve decades old problems that are inherent with flat and sloped roof protective membranes that experience a lesser acceptable service life and require continuous maintenance. You will find in the following Chapters, information

on retrofit market opportunities, pre-construction evaluation and analysis, basic roof design considerations, installation techniques, Metal Sales roof and wall systems and other helpful references. In addition, this manual provides you with what is necessary to complete a successful project that will meet the building owner's expectations.

To further enhance the use of retrofit in the construction market, its value to green building is explained in Chapter 5. In addition to the potential for increased thermal resistance with a retrofit system, metal roofing is the ideal platform for renewable energy technologies from solar hot air and water systems to photovoltaic electricity generation. Metal roofing surpasses the expected service life of conventional roofing materials and outpaces the service life of any roof mounted renewable energy technology today. Building owners can fully enjoy the benefits of a long lasting metal roof and renewable energy investment.

2 - Market Opportunity

The Retrofit Metal Roofing concept was first introduced in the late 1970's by Armco Building's first publication of a very basic *Retrofit Roofing Manual.* Since then, the concept has offered contractors, design professionals and building owners with a perfect solution to end the inherent inadequacies related to existing flat roofs. Today is no different, except there are countless more benefits with a retrofit design, such as energy conservation, sustainable design and high performance metal roof systems.

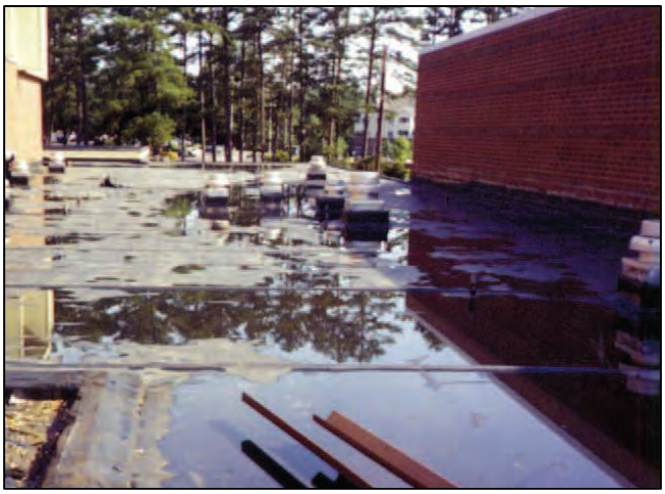


Photo 1 – Ponding water on flat roof

Flat roofs are subject to ponding water and therefore exposed to more than normal moisture infiltration and degradation. By design, they are considered to be hydrostatic (watertight) and their inability to shed water exposes them to a broader range of performance issues. Unless tapered insulation is installed to create minimal slope during a roof replacement, flat roofs must actually be more than watertight. A Retro-Master™ roof system on the other hand adds slope to a flat roof to promote drainage and a new metal roof with hydrokinetic (water shedding) properties makes it much less vulnerable to moisture infiltration and deterioration.

The retrofit market offers significant opportunity given the volume of existing building stock in the United States. For all buildings excluding residential, our nation has over 5 million commercial and industrial facilities representing more than 82 billion square feet. From a retrofit roofing standpoint, it is important to note that the prime candidate buildings are those that were built before 1990 when energy savings and roof service life were not necessarily design elements used in construction. It is estimated that roof replacements make up 60 percent[1] of America's total roofing each year. In dollars, this represents about $21 billion annually. Of this total, low slope re-roofing comprises approximately 65 percent, of the overall retrofit market projection with a potential of $13.6 billion. Based on metal construction industry research[2], a more reasonable expectation would be about 20 percent of this number or the retrofit market opportunity approaching $2.7 billion annually.

To add more value to the retrofit concept, the U.S. Department of Energy (DoE) estimates that 40 percent of our roofs are plagued with poor thermal resistance and air-infiltration. Buildings constructed prior to 1980 typically specified ASHRAE[3] thermal resistant values (R) of less than 13 compared to 26 or up to 38 today. According to the DoE's Energy Information Administration (EIA), 24 to 30 percent of cooling/heating energy use is attributed to through-roof heat gain in the summer months and loss in the winter months. These older buildings were energy inefficient.

During a Retro-Master roof replacement project, it is the ideal time to add insulation to meet Federal Model Energy Code standards or local energy codes that have been adopted. It is a cost effective measure that will provide energy savings immediately upon completion. In fact, the federal government offers IRS Section 179d tax incentives if the installation complies with minimal requirements. In addition to energy savings adding

[1] NRCA Contractor Survey - 2010

[2] Metal Construction Association/AISI Industry Analysis - 2010

[3] American Society of Heating, Refrigeration and Air-conditioning Engineers

insulation to a building that is not temperature controlled, such as a manufacturing facility, adding insulation helps to create a more comfortable work environment that generates the benefit of worker productivity.

Retrofit has been popular to several market segments. Both public and private education have embraced the retrofit concept for several decades. Based on DoE statistics, approximately 6.6 billion square feet of schools were constructed prior to 1980 to satisfy the post-war population growth in the U.S. and the ensuing generations. Today, millions of square feet of retrofitted school roofs have been performing with little or virtually no maintenance cost and no roof replacements scheduled in their future. The federal government has also recognized the value of metal roofing over conventional roof membranes and installs metal roofs over existing flat and sloped roofed facilities worldwide. Both sectors want to eliminate inevitable conventional membrane roof replacements, reduce their constant roof maintenance and conserve energy.

Compared to conventional roof membranes, metal roofing is superior in service life as shown in Table 1 and reduced maintenance in Table 2. Current market statistics establish metal with a service life over 40 year far exceeding the life expectancy of typical conventional roofs. Maintenance expense for metal is also far less than its conventional roofing competitors.

During a renovation or re-purposing of an existing building, design professionals will sometimes use retrofit re-roofing as part of their overall design. The new aesthetically pleasing metal roof becomes one of the design elements to achieve the building owner's objectives. When planning a renovation project, metal roofing's long term service life, minimal maintenance, possible reduced insurance premiums and the new roof being designed to comply with current building code requirements makes retrofit a very smart choice.

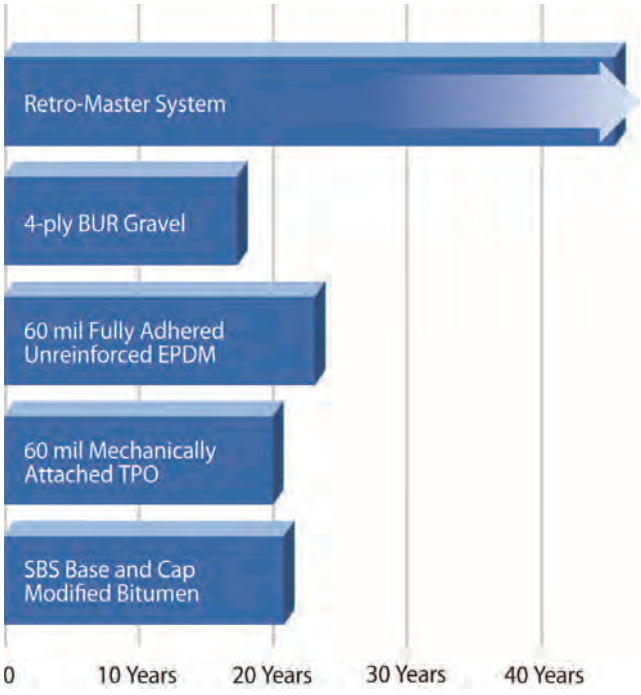


Table 1 – Average Roof Service Life Comparisons

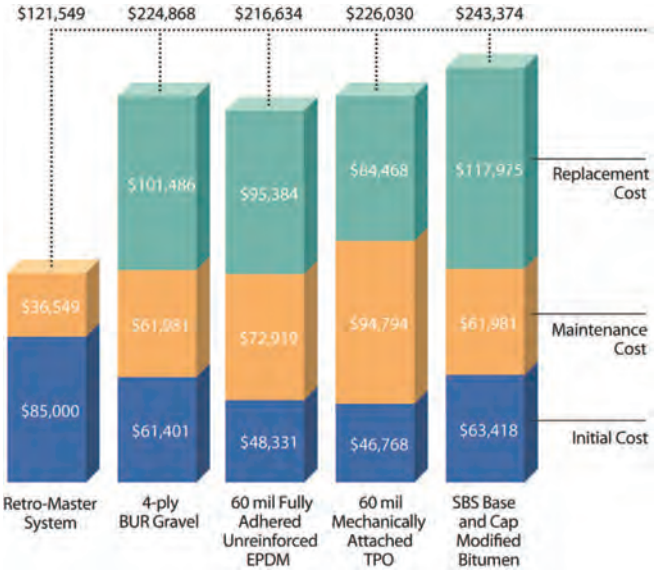


Table 2 – Average Roof Expense Over 25 Year Term
(based on 10,000 square foot flat roof with no penetrations and new bare Galvalume standing seam roof and retrofit framing not exceeding 48" tall)

Retro-Master™

Over the years, the business of retrofit has been tried by numerous contractors and metal component manufacturers. Most of these attempts have been driven by the slowdowns in our economy that resulted in the lack of new construction projects. Today, retrofit is an ideal business for metal construction contractors, especially now with energy conservation and sustainable design being at the forefront of construction in America as will be discussed in more detail in Chapter 5. Add the tremendous market opportunity and you have a winning combination.

The large inventory of aging commercial and industrial buildings with inadequate thermal resistant roofs presents retrofit opportunities. Building owners wishing to extend the service life of their properties and manage energy consumption will find a metal roof replacement an ideal solution for the long-term.

In summary, a Retro-Master project from Metal Sales™ can produce an aesthetically pleasing roof that improves your building's curb appeal, increases its appreciable value and reduces its operation costs.

3 – Applications

Retro-Master™ retrofit roof systems are designed to provide the design professional and contractor with options that can satisfy various building occupancies, conditions and geometry. Building occupancies can range from warehouses to schools and office buildings as well as hospitals and lodging establishments. No matter what the building's purpose, Retro-Master can be engineered to accommodate an architectural design where a new steep sloped metal roof is incorporated as a design element to improve the overall aesthetic value. If the building is more of a utilitarian purpose as in the case of a warehouse or manufacturing facility, Retro-Master will satisfy a low slope functional design that simply discharges rainwater from the roof. Besides architectural and utilitarian, there are always building complexes that are needing a solution to solve what the metal industry terms as "Problematic Geometry". In these cases, there may be a building complex with multiple roofs that have created challenges to satisfactorily discharge rainwater. This may be due to internal gutters and other obstacles or because the facility has undergone numerous expansions over time. As illustrated below, these challenges can include multi-gabled roofs, stepped conditions, parapet conditions that trap excessive rainfall and many others that cannot be corrected by a basic conventional flat or sloped roof replacement.

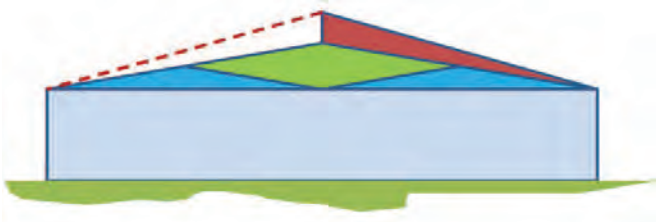


Figure 1 – Problematic Roof Geometry

Retro-Master is versatile enough to provide an ideal solution to virtually any existing building roof regardless. But it doesn't stop there. Metal Sales engineers retrofit framing to suit new construction projects as well. Light weight and cost effective retrofit framing systems have been used for hotels and other steep slope applications. The systems are especially suited for pre-cast or poured in place concrete construction where a structural concrete "attic" floor serves as the foundation for the new framing system.

Existing Roof Construction

Existing Bar Joist

Roof construction is very elementary by design. In the case of retrofitting flat roofs, they utilize a series of primary and secondary support systems with a uniform load bearing deck over the secondary members. Atop these are the insulation and waterproofing membrane. Conventional sloped roofs use similar construction.

Open web steel bar joists or steel beams and wood joists are considered secondary members. They are supported at each end by load bearing walls or primary beams of various types. Roof loading is based on specified design live, dead, wind and snow loads being transferred into the support structure uniformly through the decking over the entire roof area.

Retro-Master systems are engineered first based on the project's specified design loads using the existing roof support system as a guide. The existing roof support represents a "grid" system made up of the primary and secondary supports as explained above. This grid can be found in most types of roof construction regardless of the type of supporting members used. The spacing of the existing joists generally controls the spacing of vertical framing members and the joist span's direction typically determines the type of base members.

Figures 2 and 3 below illustrate how the change in the joist's span direction can be accommodated by just changing the retrofit framing base member type. They both accomplish the same end result for installing the new metal roof.

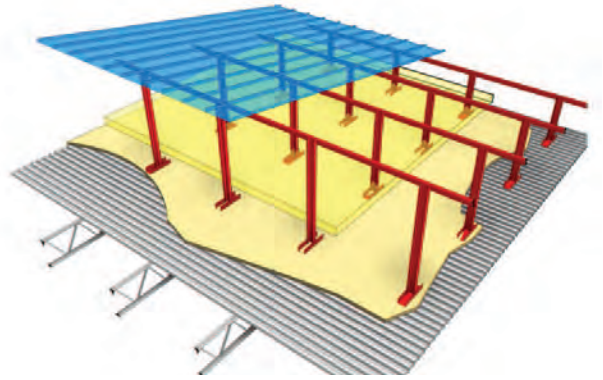


Figure 2 – Bar Joist Framed Roof - Parallel Application

In Figure 2, the new roof is sloping "parallel" to the existing bar joists. As you can see in Figure 3, the new roof is sloping perpendicular to the bar joists. The difference between the two systems is the change in base members from intermittent base shoes placed directly over each joist in Figure 2 and continuous zee shaped members positioned across the joists in Figure 3. All other framing is the same. The continuous base member allows the vertical members to be placed at intervals to support the metal roof supporting purlins necessary to meet the specified wind uplift and/or snow loads. Retro-Master systems accommodate steel framed roofs as shown in the illustrations above, but also for roofs that are constructed of wood and concrete.

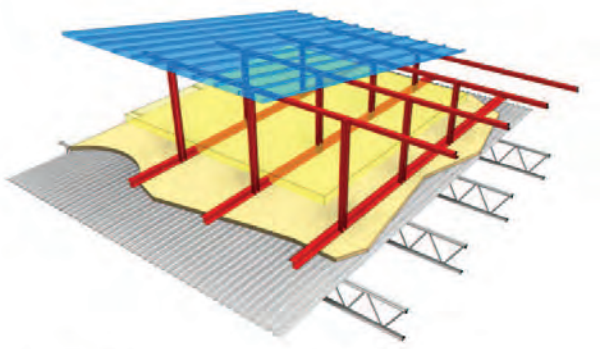


Figure 3 – Bar Joist Framed Roof - Perpendicular Application

As shown in Figure 4, the existing dimensional lumber framed roof system will always differ from the others because they will have continuous base members. In addition, vertical framing members will be spaced closer together. Both of these design elements are due to the existing wood joists typically spaced no more than 16 to 24 inches on center. They do not have the capacity to accept the heavy concentrated loads that a retrofit framing system will impose onto them. There are other types of wood framed roofs, such as heavy timber and glue laminated beam (Glulam) with structural wood decking. With these systems, it may require the retrofit framing's vertical posts to be spaced from 10 to 15 feet apart with vertical retrofit framing positioned directly over the primary supports in lieu of the secondary supports. Then the new roof purlins will be designed for longer spans compared to those of a bar joist type system.

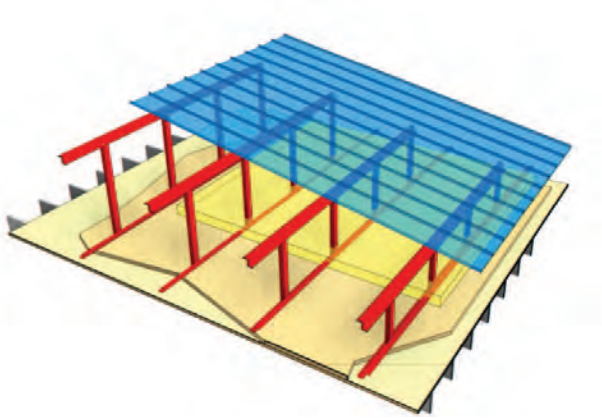


Figure 4 – Wood Joist Framed Roof - Parallel Application

For concrete framed roofs as shown in Figure 5 on the next page, these systems as mentioned before can either be pre-cast construction or poured in place structural decking. These systems are not to be confused with bar joist with lightweight concrete decking system. Those will require framing same as a bar joist framed systems. In the case of pre-cast concrete tee beam roofs, the retrofit framing is designed the same as a bar joist system. This is because the tees are typically spaced no more than

5 to 8 feet apart. Framing base members will be intermittent base shoes as shown in Figure 5. Continuous base members will be used if the new roof slope is perpendicular to the tee beam's span direction.

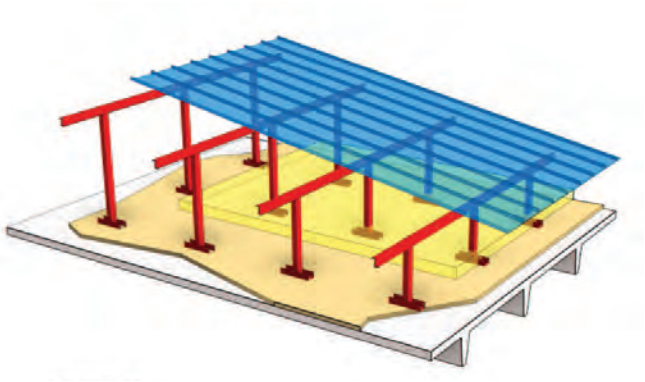


Figure 5 – Concrete Tee Beam Roof – Parallel Application

Another Retro-Master system for flat roofs shown in Figure 6 below is for utilitarian low slope framing that utilizes varying height zee shaped purlins to create slope. This system is for minimal sloped applications between ¼:12 and ½:12 roof pitches using the Metal Sales Seam-Loc 24 and Snap-Loc 24 standing seam metal roof systems. Because of the physical height limitations of the purlins used in this system, it is only adaptable to gabled buildings less than 100 feet wide or 50 foot monosloped roofs. Other Metal Sales roof panel systems are available for roof pitches above ½:12.

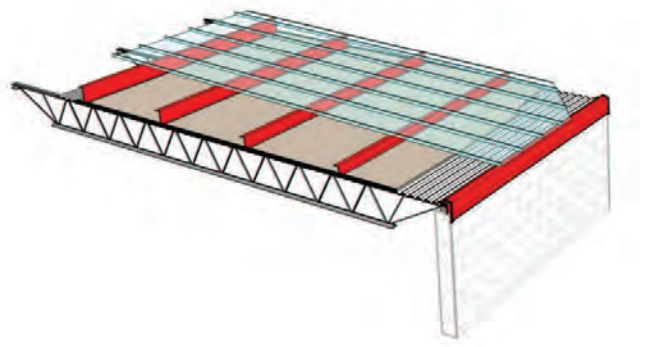


Figure 6 – Low Slope Framing System - Perpendicular

Another framing system available from Metal Sales is a simple sub-framing system for existing sloped roofs that have conventional membranes as shown in Figure 7 below. For this system a hat-shaped continuous member is designed and placed perpendicular to the roof pitch at intervals to withstand the design wind uplift loads as based on the selected new metal roof.

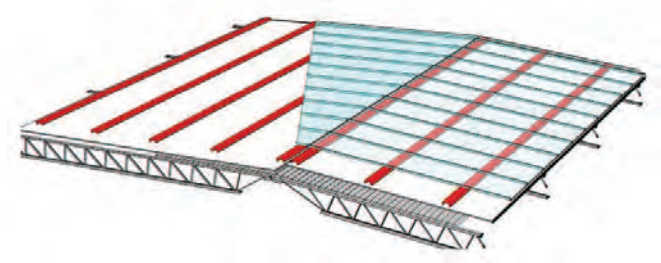


Figure 7 – Metal-over-Sloped Roof System (Bar Joist Shown)

Metal Sales has partnered with Roof Hugger™, Inc. for their unique factory-notched sub-purlins that are designed to install over existing metal roofs that have reached the end of their service life. The value of this framing system is the old roof will normally not require removal. For more information on this Metal-over-Metal re-roof solution, contact Metal Sales.

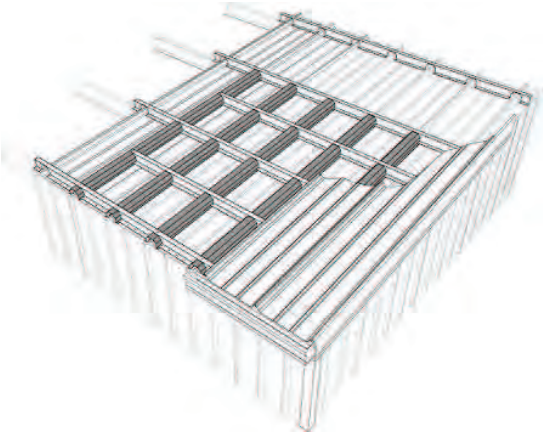


Figure 8 – Roof Hugger Metal-over-Metal Sub-Framing

From the illustrations and information provided in this chapter, you can see how the existing roof support system will control the design of the new retrofit framing. Also, you will now understand the difference between parallel and perpendicular and why different base members are necessary to accommodate changes of roof supports and/or joist span direction as well as the new roof geometry that may create hips and valleys.

Why Conventional Roof Membranes Fail

Now that we have provided you with some basic fundamentals of retrofit framing system design, let's explore why conventional roof membranes fail. First let's identify some of the membranes that are subject to be replaced more often and are commonly retrofitted with metal.

The most common roof membrane is multi-layer built-up asphalt with gravel aggregate (BUR). This membrane has served the roofing industry for decades, only now to losing market share to the more advanced systems like standing seam metal roofing, elastomeric EPDM and thermoplastic TPO membranes (singles plies). Service life spans shown in Table 1 in Chapter 2, the BUR has an average service life of 17 years and single-plies a little over 20 years. Table 2 provides the average cost for maintenance.

The following provides some principle reasons why conventional roofs fail and why they are inferior to metal's service life of 40 to 60 plus years and low cost maintenance.

Multi-layer BUR Issues:

- Physical damage due to foot traffic
- Building movement
- UV exposure
- Thermal cycling and embrittlement
- Thermal shock (after rainfall)
- Ponding water
- Difficult to maintain and repair

Single-ply Sheet Systems:

- Seam failure and separation
- Prone to punctures
- Infrared exposure
- Shrinkage and swelling due to thermal cycling
- Difficult to maintain and repair

With metal roofing, none of these issues are threatening to the integrity of the roof. Metal Sales standing seam metal roofs are designed to accommodate thermally induced stresses and building movement alike, and with minimal affect from ultraviolet or infrared exposure.

Summary

Earlier in this chapter we noted that roof construction is very elementary in design. However, what is most important in a retrofit application is the design professional or contractor's upfront inspections of the existing roof in order to identify what makes up the roof's structural grid and its composition. Once this is determined, Metal Sales will be able to engineer the retrofit framing and metal roof system. Without this information, potential pitfalls can lead to an unsuccessful project or even a catastrophic roof failure. In Chapter 4, this inspection process is discussed in detail along with a description of the ideal retrofit "Project Team" made up of the contractor, design professional and Metal Sales. A successful retrofit project starts with this team.

4 – Design Considerations

The process to begin a retrofit project starts long before Metal Sales™ receives a request for an estimate or an order to engineer, manufacture and ship materials to the jobsite.

First and foremost, it is important to understand a retrofit changes the existing building roof geometry and the structural integrity of its support system. If not engineered properly, the results can be devastating with the design professional and/or the contractor holding the liability.

This chapter addresses building code compliance and considerations during pre-bid, pre-construction and construction that will lead you to a successful project. At the end of this chapter, we explain the role of each member of the project team.

Building Code Compliance

A retrofit project is not to be confused with "re-roofing" or roof repair. In nearly all applications, the project will be subject to local building code review and approval. This means, engineering analysis and installation documents must be prepared and submitted to obtain a building permit. This may however, differ if your retrofit is a metal-over-metal application, but for metal-over-flat and metal-over-conventional sloped roofs, but many differ for a metal-over-metal application. Check with your local building code office to confirm your responsibilities and design requirements. The following are some primary points to address building code compliance.

1. A retrofit assembly over a flat roof creates a cavity, or "attic space", between the old and new roofs. This space should be ventilated to assist in condensation control and to help dissipate any trapped moisture in the existing substrate (membrane, insulation and decking). If the building code official considers this space as an attic, then it will be subject to building code compliance. In this case, ventilation will be required as explained in chapter 5.
2. The level of fire protection will be identified in the code and it is not uncommon for fire/smoke partitioning to be required if the project is large enough. These partitions are simple walls constructed from the existing roof to the underside of the new roof, typically separating the space into 2500 to 3000 square foot areas. Various materials from oriented strand board (OSB) to sheet rock have been used for covering the walls, but you may want to check with your local building code office to determine what is acceptable.
3. Depending on locally adopted energy codes, compliance by adding insulation may or may not be required during a retrofit. It is suggested however that additional insulation is installed to comply with the minimum recommended thermal resistance values (R) in the Federal Model Energy Code. This topic is discussed in much more detail in chapter 9.

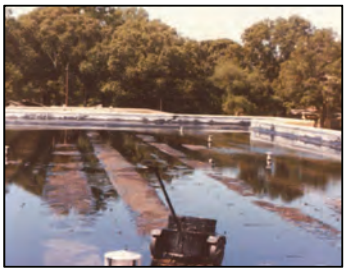
Pre-bid Considerations

Deteriorated ceiling and exposed wood framed roof support system

Prior to requesting a quotation from Metal Sales, it will be necessary to visit the project and conduct a thorough survey of the existing roof system. The complexity of the process is dependent on the existing building, access to the underside of the existing roof and determining the building owner

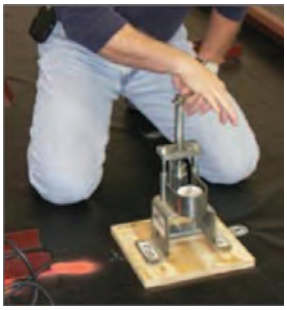
objectives are with retrofit roof replacement. The following outlines primarily what you will need later in the design and installation as well as what is required for Metal Sales to produce an engineered estimate and final design.

1. Inspect the existing roof above and below for deterioration from a water logged substrate. If the roof has areas that are water logged, they will need to be evaluated for possible removal. Refer to base member attachment details for inadequate substrates in chapter 10 for more information. In some cases, an entire removal of the membrane and insulation may be necessary. When this is done, rolled temporary roofing can be used to protect the building from rainwater infiltration during construction.



Water on roof could be a sign of possible issues or future concerns.

2. If applicable, inspect existing aggregate/ballast and determine if it should be removed and disposed of if local environmental restrictions permit this.
3. Create a rooftop sketch that illustrates and explains the following:
   A. Specific dimensions at the roof's perimeter as well as height from ground level and/or adjacent roofs.
   B. Parapet width and height above roof (if applicable).
   C. Locate rooftop HVAC equipment from two roof edges and note the width, length and height above the roof.
   D. Locate existing roof drains.
   E. Locate skylights, access hatches and other openings.
   F. Locate sanitary vents and determine if they need to be re-routed or combined into less frequent penetrations through the new roof or walls.
   G. Note any slope inconsistencies or elevation changes in the roof, and any other appurtences that will need to be incorporated into the new roof geometry and design.
4. While not necessary during the pre-bid process consider performing pull-out testing for anchor selection and framing attachment design using a calibrated pull-tester. On a large project, the anchor costs can be significant. Knowing specifically what to use and quantity required to satisfy wind uplift design can be cost prudent. Most fastener distributors offer this service on a local basis. While conducting these tests, the following should be performed as well:



Pull-out test being performed

   A. With the results from the pull-out testing, an analysis should be performed using the wind uplift values provided by Metal Sales in their post-order design documents. It is important to note that multiple values will be necessary based on conditions, such as interior framing base attachments and roof edge attachments. The Metal Sales provided wind uplift values should be increased with an applied or specified safety factor. To explain this, if the design requires an ultimate 1000 pound pull-out resistance, then this value is multiplied by the safety factor of 2.5 which is commonly specified, then the total required pull-out at each anchorage connection will be 2500 pounds. If the onsite pull-out testing recorded a value of 700 pounds at interior framing base members, the quantity of anchors required would be 4 each (4 x 700 = 2800, which is greater than 2500). For estimating, an approximate quantity of anchorage locations can be found in the Metal Sales' Retro-Master proposal, but understand that these

will not include any anchors at the roof's perimeter walls, only those for the interior framing locations. Therefore, the number provided will be locations only and not to be confused with quantity of anchors. The quantity at each location is to be calculated by the contractor or the design professional.

B. Identify the type of existing membrane as this is needed to select a compatible waterproofing/sealant to temporarily protect the anchor penetrations.

C. Determine the depth/thickness of the existing insulation for estimating what the existing thermal resistance may be. This will help in determining how much additional insulation will be required to meet energy code requirements. To identify the thickness, you can measure the top of the roof membrane down to the existing deck by probing. Remember, that the insulation thickness may not be consistent and therefore multiple locations should be probed.

D. During the pull-out testing, test the compressive strength of the existing substrate (membrane and insulation). As you will read later. These values are necessary to determine the size of shims or blocking that will be required to satisfy the imposing loads of the new retrofit system and design loading.

5. Gain access to the underside of the existing roof if at all possible. This is the only method to discover existing roof information and its support system, unless an original set of construction drawings are available from the owner. If they do existing, understand that not all information will be available or possibly accurate. The following is the information that needs to be recorded in your survey and inspection:


Inspecting under roof structure

A. Inspect the existing roof decking for deterioration and determine if any areas require removal and replaced before construction of the retrofit framing can commence.

B. Identify the type and size of existing joists (steel beam, open-web bar joist, dimensional lumber, heavy timber beams, concrete beams, concrete tee beams, etc.)

C. Obtain the spacing and span direction of the existing joists or beams.

D. Locate existing primary supports, those that support the joists or beams.

E. Using C and D, indicate on the roof sketch, the primary and secondary grid system showing joist spacing and span direction.

F. Identify any electrical, heating/air-conditioning, gas and water piping or other equipment that is installed tight to the underside of the existing roof deck. Locating these will help you to prevent penetrating them when installing retrofit framing anchors during construction.

<u>Considerations Prior to Construction</u>

In "Pre-construction Due Diligence", a roof examination and analysis are necessary to determine existing roof geometry, the final design and the scope of work. This includes a structural analysis of the existing roof support structure to determine the affect a new retrofit will impose on the building. It also identifies other options will be incorporated into the project to make it safe and building code compliant.

Besides geometry modifications, a retrofit brings about some drastic changes to the existing roof. The following explains what needs to be addressed after your roof survey and prior to construction.

1. It is important to understand that the Metal Sales retrofit framing and metal roofing system will add a considerable amount of weight onto the existing roof. Since the old roof was not

originally designed for this additional weight, the overall design weight must be accommodated for. As an example, if the new material weight is approximately 3 to 5 pounds per square foot (psf), then the original design live load of the roof is actually reduced and the building may no longer comply with the local building code. Better explained, if the original live load was 20 psf, then you have now reduced it to 17 psf or 15 psf resulting in an existing roof that may now be overloaded.

2. If the existing roof has gravel or other type of ballast, remove it to help compensate for the retrofit assembly weight. In most cases, the ballast will weigh more than the retrofit assembly.
3. The existing roof and its bracing system will receive lateral loads from the new construction. Because of this, the existing building must provide a serviceable diaphragm for bracing itself. Please note that removing the existing decking most likely render the building unbraced and unstable.
4. The new retrofit framing must only be attached to the existing roof system in a way that it will prevent it from blowing off during a storm. There are roofs that have failed with only 70 mile per hour (mph) wind speeds, when the code required 90 mph. The key to this is attaching to the existing roof's support system only, based on an engineering analysis, selecting proper anchor type(s) and calculating anchor quantity at each retrofit framing base attachment location. For some of Metal Sales base members, a minimum quantity of fasteners are required. This is to prevent twisting, prying or other degradation to the retrofit base members under load. Refer to the standard construction details in chapter 6 for more information.

Failed retrofit roof system

5. If an existing roof substrate that has trapped moisture is to remain in place and (not be removed), premature failure of your retrofit anchors could result as well as moisture migrating into the building if the "attic" space is not properly ventilated. It is recommended that all anchors that penetrate the roof substrate shall have a corrosion resistant coating or be stainless steel.
6. As previously mentioned, the existing roof substrate must be tested to determine its compressive strength. The physical dimensions of the base member at each attachment point must accommodate the downward acting gravity load to prevent depressing the substrate. Failure to do this can result in severe undulation in the new roof after the first snowfall, long after the job is completed.

After the information described above is collected from your roof survey, a structural analysis of the existing roof system can be performed by a licensed design professional. This analysis will use criteria found in Metal Sales' design documents, which includes both gravity and wind uplift loads at the new framing base member and anchorage locations and information obtained during the survey and rooftop testing. This analysis will ensure the existing roof will not be overloaded and it will pave the way for an anchorage system analysis to be performed.

<u>During Construction Considerations</u>

1. During retrofit framing installation, all penetrations made through the existing roof assembly must be sealed temporarily with a compatible sealant. Roof leaks during construction are as objectionable as roof leaks at any other time. With a retrofit, depending on the size of your roof, literally thousands of holes will be created due to anchoring the retrofit framing systems. Check with your fastener distributor for a compatible sealant or temporary

waterproofing to be used based on the type of existing membrane.

2. If your retrofit design requires continuous type base framing, normally zee-shaped members; it is wise to shim these enough to permit rainwater to drain to the existing drainage system. Otherwise, you may very well dam the rainwater on the roof, causing major leaks or even worse a catastrophic roof failure due to the excessive weight from ponding water. Normally a shim thickness of about one-half inch will suffice.

Flooded roof due to continuous members damming rainwater by not having shims installed beneath them

As you can see, there is much to consider before you start construction of a retrofit project. You may want to consider consulting with a design professional, which helps in ensuring the project is in compliance with the locally adopted codes and restrictions.

The Retrofit Roofing concept is a fully-engineered system that requires upfront examination and much preparation before the construction can commence. A properly staffed "Project Team" will best suit the needs of all involved and ensure project safety. Based on the metal construction industry's practices[1] and terminology relating to the design, manufacture and installation of its products, each member of the Project Team has specific roles and responsibilities as follows:

Building Owner (End Customer) - The party who is the owner of the construction project. For a specific construction project, the building owner may act as the general contractor. If the building owner purchases "materials only" from the roofing contractor, the building owner has the responsibility for the installation of the metal roof system as provided.

Design Professional - The design professional is vital to the Project Team. An architect, engineer or roof consultant who is legally qualified to perform structural analysis will ensure the existing roof and the structural integrity of its support system is maintained. In a design-build project delivery method, there are construction companies that are legally qualified to do both the design and construction on retrofit projects.

Retrofit System Manufacturer - An equally important team player is the system's manufacturer that is qualified to engineer the new retrofit framing and metal roof systems as well as provide the materials needed to construct the project. Metal Sales responsibility is as follows:

A. Metal Sales is responsible, through its engineering resources that is legally qualified to design the retrofit framing and metal roofing system to comply with the design criteria as specified in the project documents and as the Metal Sales resulting order documents.
B. Metal Sales is responsible for only the structural design of the retrofit framing and metal roofing system it supplies to the roofing contractor. Metal Sales or its employed engineer is not to be considered the "design professional" or "Engineer of Record" on the project. Metal Sales is not responsible for the design of any components or materials supplied by others including, but not limited to, framing anchors, existing roof support system or other materials that interface and/or

[1] Taken in part from the 2012 2nd Edition of the Metal Roofing Systems Design Manual, published by the Metal Building Manufacturers Association (MBMA) Cleveland, OH

connect to the retrofit framing and metal roofing system.

Roofing Contractor - The team member that orders and purchases the retrofit framing and metal roof system from Metal Sales and installs all of the materials to complete the project. The roofing contractor may or may not be a sub-contractor of a general contractor, but is an independent contractor and is not an agent of Metal Sales.

Overall Design Responsibility - When the building owner hires a design professional for a construction project, it is the responsibility of the design professional to specify the design criteria including all applicable design loads. When the building owner does not retain a design professional, it is the responsibility of the building owner to specify the design criteria and applicable design loads. In any event, it is the responsibility of the roofing contractor to interpret all aspects of the building owner's specifications and incorporate the appropriate specifications, design criteria and design loads into the order documents submitted to the systems manufacturer. Concerning the design analysis of the existing roof system and its ability to receive the weight and the newly imposed loads of the new retrofit framing and metal roof system, this legally falls under the design professional's responsibility as the "Engineer of Record" on the project.

5 – Energy Savings

Green or sustainable design is becoming a common practice in new construction and renovation projects. Building owners now have the opportunity to achieve significant energy savings when tackling a roof replacement. If the building owner is interested in pursuing LEED(R) certification, a Retro-Master™ systems paves the way to compliance. The United States Green Building Council (USGBC) rating system for Existing Buildings: Operations & Maintenance provides criteria to address water and energy use, environmentally preferred products and exterior building site maintenance programs. A retrofit system has the potential of contributing up to 29 points towards building certification.

High performance retrofit roofing systems introduces an opportunity to utilize proven and commercially available technologies to help achieve a sustainable building. A Retro-Master project can utilize the surface of the new Metal Sales™ roof as well as the space between the old roof and bottom side of the new roof to install the following energy saving technologies.

Increasing Thermal Resistance With Insulation

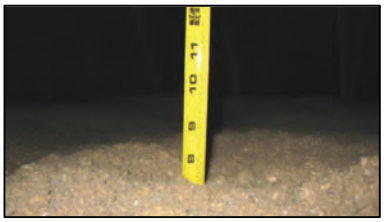


Photo 1 – Blown Cellulose Insulation

As simple as it sounds, adding insulation between the old and new roofs to increase thermal resistance can reduce energy use. Whether the decision is to upgrade to locally adopted energy code requirements or to install insulation with thermal resistance values up to R-50, it is a cost effective option that provides a return on your investment in the form of reduced energy consumption. While it is particularly applicable to buildings that are temperature controlled, added insulation in buildings that are not will create a more comfortable work environment for its occupants.

Photo 2 – Unfaced Fiberglass installed over existing roof

A very important point to remember when adding insulation to a retrofit project, is the benefit of the existing insulation's R-value counts towards the total value you wish to achieve or what may be required by local energy codes. In Chapter 9, Tables 1 and 2 we have provided the insulating R-Values of common older roof construction products and those values of insulation products used today in retrofit. These tables can be used to determine what best suits your project to achieve necessary results. In a retrofit over a flat roof, rolled fiberglass batt insulation or blown loose fill cellulose is best suited, while for retrofits over sloped roofs, fiberglass or rigid board insulation such as polyisocyanurate works best. Using a laminated vapor barrier in either application does not suit the installation well. In the retrofit over flat roof installation, the vapor barrier can actually trap moisture in the existing roof creating a deteriorating environment. For Metal-over-Sloped installations, it also traps moisture and it is not needed since the existing roof acts as the barrier itself.

Renewable Solar Technologies

Buildings of the future will be routinely cladded with renewable energy systems that play an active role in building energy management. Today's progressive designers of both new and re-roofing applications can easily implement building envelope systems that can heat and cool both air and water and produce electricity in one common area. Below are the technologies that relate to a retrofit assembly.

Solar Electricity

The world is abuzz with the potential of solar power to measurably impact the levels of fossil fuel use and reduce the rate of climate change. Known as photovoltaic (PV) systems, these systems convert sunlight into electricity. Though expensive when compared to today's conventional power generating systems, manufacturers are driving the production costs down as they bring new renewable energy products, known as building integrated photovoltaic's (BIPV) to the building envelope marketplace.

Photovoltaics are available in two different product applications. First is thin-film laminated PV shown in Photo 3 below, which comes prepared with a peel and stick butyl mastic adhesive on the back side. The laminated PV is known to be more productive in low sunlight. These can typically be installed at the jobsite depending on weather conditions or indoors in a controlled environment prior to shipment to the jobsite.

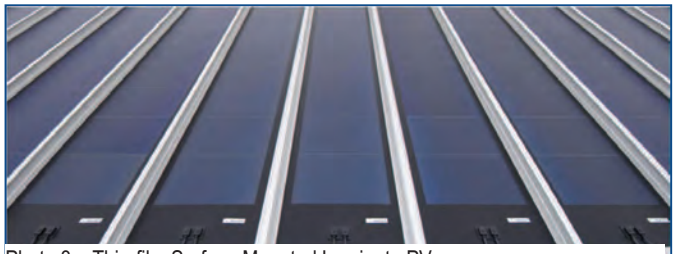


Photo 3 – Thin-film Surface Mounted Laminate PV

The second type of PV is modular framed glazed systems as shown below in Photo 4. These higher efficiency systems are manufactured in various types of assemblies. The glazing over the photovoltaic cells is crystalline panels. They can be installed by themselves or a multi-panel array. These systems are more productive in bright sunlight and offer a much greater output relative to space needed.

Photo 4 – Modular Surface Mounted Crystalline PV

Solar Thermal Air and Water

Another renewable solar technology is solar thermal energy as shown in Photo 5 on the next page. Solar thermal systems produce heated air or water from the sun's radiation on the new metal roof for use in domestic hot water, space heat or process heating applications. Suitable for both new and retrofit installations and highly cost effective today, these systems lack the sizzle (and the rebates) of PV systems that produce electrical power and contributed to the national electrical grid. However, architects adopting building integrated solar thermal (BIST) systems have a vast array of building cladding materials, finishes and colors on their design pallet and when a building's cladding material becomes the solar absorber, owners are delighted by the additional financial incentives available under the Federal Investment Tax Credit (ITC) program of IRS Section 179d as explained later in this Chapter.

Solar thermal and thin-film PV systems can be synergistically engineered into one integrated PV-Thermal envelope assembly. Called BIPV-T, these systems are capable of producing 2 to 4 times the energy available from a thin-film PV system. The

solar thermal system cools the PV increasing its efficiency, while cooling the building envelope and putting otherwise waste heat to work in the building. The entire BIPV-T system is eligible for the Federal ITC and related state and local rebates and incentives.

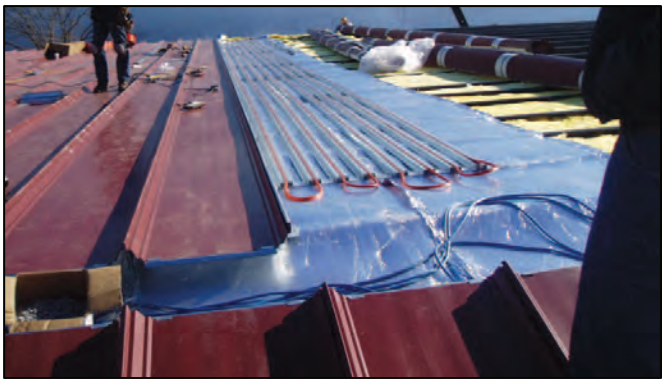


Photo 5 – Closed Loop Solar Thermal Hot Water System

Ventilation of Space Below New Roof

For a retrofit over an existing flat roof, ventilation may be subject to code compliance as specified in the International Building Code (IBC) under section 1203.2. This is dependent on if the code enforcement review establishes the space between the old and new roofs as an "attic space". In many projects, ventilation has not fallen under the guidance of a code authority, but one of the unwritten rules of retrofit is this space should be ventilated. Check with your local code officials to determine what is required.

In a retrofit application, ventilation will assist in controlling condensation at the underside of the new metal roof due to temperature changes during the day. It also allows possible trapped moisture in the existing roof to dissipate. The IBC requires the net ventilated free area (NVFA) shall not be less than $^1/_{150}$[1] of space's volume to be ventilated, with 50 percent of the required ventilating area located in the upper portion of the space to be exhausted and the balance of the area to provide fresh ambient temperature intake air from the eaves. The $^1/_{150}$ NVFA will in most cases require installing power ventilators in lieu of gravity ventilation as a $^1/_{300}$ factor will, which is a more typically specified factor for retrofit applications. In addition, some design professionals have required 3 to 4 air changes per hour, which simply means exhausting the volume of the space at a specified number of times and replacing it with new intake air each hour.

Retrofits over sloped roofing, a very well tested ventilated roof assembly has become very much desired in recent years because of its cost effectiveness. Shown in Photo 6 on the next page, the assembly is called Above Sheathing Ventilation (ASV). This type of ventilation is actually not a new technology as it has been used on tiled roofs for decades. It's based on convection as explained on the next page. Case studies and real world laboratory tests confirm ASV can reduce energy consumption by 20 to 40%. ASV can be installed over existing sloped roofs by installing a sub-framing system that permits airflow beneath the new metal roof. In the case of a metal over existing metal roof, our Roof Hugger® sub-purlin system accommodates ASV very well by also providing for both new direct fastened and standing seam metal roofs. The standing seam however must be installed with a one-inch stand-off clip. The ASV assembly can accommodate the addition of fiberglass or rigid insulation but must provide a minimum of one-inch airflow above the insulation which a standing seam achieves this with a stand-off clip. Figure 1 on the next page illustrates an ASV assembly that includes a Roof Hugger® sub-purlin, insulation (fiberglass or rigid board), radiant barrier and a popular purlin vent strip that is available from Cor-A-Vent™.

[1] One square foot of intake and exhaust airflow area per every 150 cubic foot of attic volume

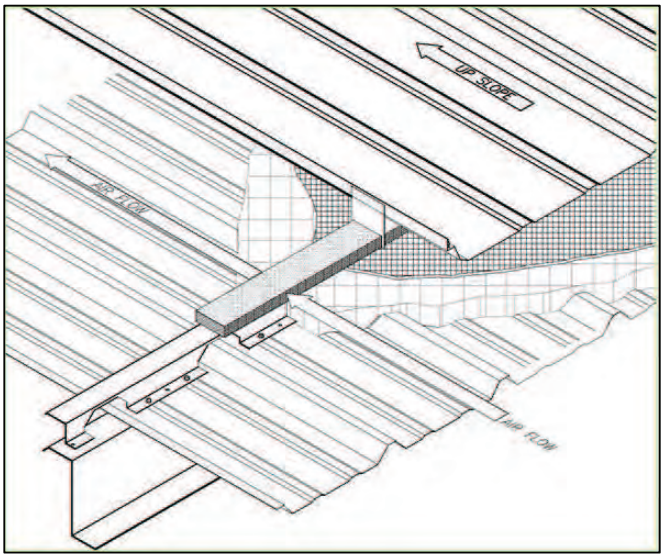


Figure 1 – ASV Application Over Existing Metal Roof

How does ASV work? Fresh air is introduced to the cavity between the old and new roofs through ventilation at the low eave of the roof. When the sun radiates its heat on the new metal roof, the cavity air becomes less dense. This causes the air to become more buoyant and therefore begins to move up slope along the immediate underside of the new metal roof. The air is then exhausted at the high point of the roof (ridge, etc.) through convection. The end result is the system creates an insulating barrier of air between the two roofs. The steeper the roof slope, the more efficient the assembly becomes.

The ASV assembly has been tested at Oak Ridge National Laboratory's (ORNL) Building Envelope Technologies Group since 2006. The results indicate that the system reduces the heat radiation through the roof assembly a minimum of 30% and as much as 45% when the new roof has a "Cool-Rated" coating/paint system. Effectively, an ASV system creates an air barrier, which reduces heat gain in the summer and heat loss in the winter, very much like adding insulation.

Rainwater Harvesting

A centuries old technology is gaining popularity in the construction of buildings. Rainwater collection, or harvesting, is a simple and cost effective method of capturing rainwater for non-potable water uses where permissible by law. It can be incorporated into a building's potable water supply if a purification system is installed as well. Storage for collected rainwater can be above ground or below ground. One of the most effective uses for this technology is to supply water for grounds irrigation. There are many equipment manufacturers and suppliers for these systems. The technology also contributes to LEED® points for building certification. From an 11,000 square foot retrofitted roof, shown in Photo 6 below shows a warm-dry climate installation in west Texas that produces 130,000 gallons of landscape irrigation water under normal annual rainfall. This system provides ample service to the approximate 1.5 acre grounds with above ground storage.

Photo 6 – Above Ground 10,000 Gallon Rainwater Storage

Other Technologies on the Horizon

Innovative product components called Phase Change Materials (PCM's) are now being specified in mainstream products such as drywall. ORNL is working on the integration of PCM's into optimized envelope systems, increasing their ability to store thermal energy and transfer it to the building when needed in conjunction with cool roofing, thin-film PV and ASV applications. PV paints for roll to

roll/continuous coating and PV inks with related printing processes are on the horizon.

Metal roofing is the ideal platform for renewable solar, the energy saving and renewable solar technologies state of the art sustainable design. With the typical warranted life of roof mounted renewable solar technologies having been established between 25 and 30 years conventional roof replacement is not a solution. As explained in Chapter 3, conventional roof membranes have an average service life that is less than solar. This means the building owner may have to remove the solar equipment, replace his/her conventional roof at the end of its service life and then re-install the solar. Metal roofing with its superior service life of over 40 years is the only proper and cost effective platform to install surface mounted solar.

ORNL continues to conduct research and testing on the next generation of sustainable energy envelope systems. Building on a deep knowledge base acquired over many years of research and development, with federal funding and industry sponsorship, ORNL is working with industry partners and trade associations such as the Metal Construction Association (MCA), Cool Roof Rating Council (CRRC) and others to develop, test and commercialize the next generation of roofing and curtain wall products for new and retrofit construction.

Federal Tax & Other Incentives

Under the conditions of the Energy Policy Act of 2005, commercial buildings that improve their energy efficiency are eligible for tax deductions as allowed by the U.S. Tax Code.

The amount deductible for non-solar insulation and ventilation installations may be as much as $1.80 per square foot of building floor area for buildings that achieve a 50% reduction in energy and power costs. For buildings achieving less than 50%, a lesser deduction is still available as long as they achieve a minimum energy and power costs reduction of 16.67%.

Tax incentives for renewable solar installations are significantly more than the non-solar ones. Under the conditions of the Economic Stabilization Act of 2008 and the more recent American Recovery and Reinvestment Act of 2009 (a.k.a. Stimulus Bill), commercial building owners that improve their energy efficiency using solar systems are eligible for tax credits as allowed by the U.S. Tax Code. These credits have been extended for projects completed prior to January 1, 2017. The tax credit amount is a dollar-for-dollar credit that equates to 30% of the total in-place cost of the system (roof panels and mechanical/electrical equipment including labor). In some retrofit over sloped roofs, the sub-framing system has been included in the credit. In addition, the installation is eligible for IRS bonus depreciation, which allows 50% the first year and the balance over the following five years. Depending on the State your project is located in a multitude of loan guarantees/funding, grants, renewable energy bonds and tax programs are available. Consult your tax professional for specific investment tax credit details and what can or cannot be included. You may also visit www.dsireusa.org to explore what incentives are currently available in your local area.

Summary

It is important to understand that all of these technologies are applicable for not only new construction, but even more so for existing buildings. As mentioned before, the DoE's Energy Information Administration reports that the existing 5 million plus commercial and industrial facilities consume 74.7% of our building energy demand or 29,189 Trillion BTU's per year for cooling and heating.

Needless to say, the opportunity to reduce our building energy consumption is with upgrading existing buildings through retrofit roof systems.

6 – Framing Systems

Retro-Master™ framing systems are versatile enough to accommodate most any roof replacement condition. Using standard cold-formed steel products and other miscellaneous members, they form a structurally correct rigid framework that creates slope for a new Metal Sales metal roof system to be installed. Since each project varies in geometry, height and purpose, they are specifically engineered to comply with project specific design intent and specified loading.

This Chapter provides information about the components used in the Retro-Master framing systems and suggested installation practices. Refer to the standard framing construction details provided in Chapter 10 for further details.

The structural components and their connections in the Retro-Master framing systems are designed in accordance with AISC[1], AISI[2] and LGSI[3] design specifications as applicable. Deflection requirements are in accordance with the applicable building code, or as a minimum, the provisions of the AISC Steel Design Guide Series 3 – Serviceability Design Considerations for Low-Rise Buildings.

It is important to understand that some framing components will require field-cutting. These members include, but are not limited to, base shoes, sleeper zees, vertical cee posts, canopy framing and others deemed appropriate by Metal Sales. In some cases, zee purlins will also require field cutting at hips, valleys and other conditions. The contractor/installer has the option to specifically request factory cut-to-length members with the understanding that the associated cost will be included in the Metal Sales proposal.

Installation documents (shop drawings) are included with all Retro-Master orders as prepared by Metal Sales. These documents shall be submitted to the contractor/installer for their "Approval" prior to final detailing and take-off of materials. The roof and wall panel lengths provided in the installation documents are based on existing roof dimensions and other information provided to Metal Sales with the order contract. The contractor/installer must verify and approve panel lengths prior to final release for manufacturing and shipment to jobsite.

The contractor/installer is responsible for providing adequate load bearing beneath all framing base members at their attachment points to the existing roof system. This is necessary to prevent depressing the existing roof assembly and causing undue inconsistencies in the new metal roof once subjected to design load (snow). As illustrated in our standard details, you can accomplish this by installing proper blocking at each inadequate roof substrate location.

Framing Components

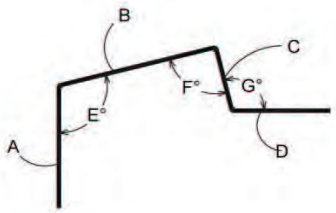
The standard structural framing components that are used in the Retro-Master assemblies are described and illustrated on following pages:

[1] AISC - American Institute of Steel Construction
[2] AISI - American Iron & Steel Institute
[3] LGSI - Light Gauge Steel Institute

Retro-Master™

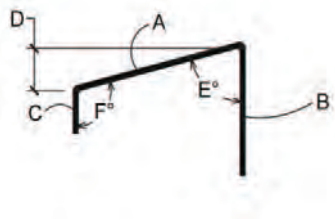
All framing is ASTM[4] A 1011, Grade 55, Class 2 (55 KSI min yield) steel with standard red oxide finish or optional ASTM A 653, Grade 55, Class 2 (55 KSI min yield). Please note that member depths and thicknesses are determined by design on a project by project basis.

- Low Eave members are custom fabricated to the specific slope of the new roof. They are designed to anchor to the existing roof structure at the top side and to the wall at their face (A). These members do not allow for any inconsistency in the elevation at the existing roof edge. A two-piece eave assembly is provided if there is inconsistency at the roof edge.



Low Eave - All dimensions in inches				All Materials 16 ga.		
Slope	1/2 to 1:12	2:12	3:12	4:12	5:12	6:12
Girth	11 15/16	11 15/16	11 15/16	11 15/16	11 15/16	11 15/16
A	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2
B	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2
C	1 5/16	1 5/8	1 7/8	2 1/4	2 9/16	2 7/8
D (Wild)	3 5/16	3	2 3/4	2 3/8	2 1/16	1 3/4
E°	93°	99°	104°	108°	112°	116°
F°	90°	90°	90°	90°	90°	90°
G°	93°	99°	104°	108°	112°	116°
Part No.						

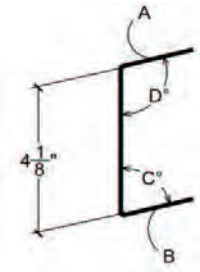
- Eave Caps are custom fabricated members for universal use with the Two-Piece Eave Base and elevated low and high eave walls. Made to the specific slope of the new roof, they are designed to fit and be field adjusted to create a properly aligned and leveled eave.



Eave Cap - All dimensions in inches				All Materials 16 ga.		
Slope	1:12	2:12	3:12	4:12	5:12	6:12
Girth	9 15/16	9 15/16	9 15/16	9 15/16	9 15/16	9 15/16
A	4 1/8	4 3/16	4 1/4	4 3/8	4 1/2	4 5/8
B	2 1/2	2 1/2	2 1/2	1 3/4	1 3/4	1 3/4
C	3 5/16	3 1/4	3 3/16	3 13/16	3 11/16	3 9/16
D = Rise	5/16	11/16	1	4 3/8	1 3/4	2 1/16
E°	87°	81°	76°	72°	68°	64°
F°	93°	99°	104°	108°	112°	116°
Part No.						

- Sloped Eave Channels are used for special eave conditions and to cap eave overhang outriggers and installing eave flashing at a continuous eave member. They are custom fabricated members and have their flanges made to a specific roof pitch up to 4:12. The 4 1/8" web as shown on the next page may vary in depth if 6" or 8" outriggers are necessary to provide extensions greater than 2'-6". See next page for details and dimensions.

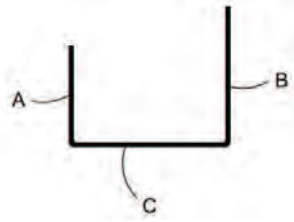
[4] ASTM – American Society for Testing and Materials



Sloped Flange Channel - All dimensions in inches - All Materials 16 ga.						
Slope	1:12	2:12	3:12	4:12	5:12	6:12
Girth	$9^{15}/_{16}$	$9^{15}/_{16}$	$9^{15}/_{16}$	$9^{15}/_{16}$	$9^{15}/_{16}$	$9^{15}/_{16}$
A	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$
B	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$
C°	87°	81°	76°	72°	68°	64°
D°	93°	99°	104°	108°	112°	116°
Part No.						

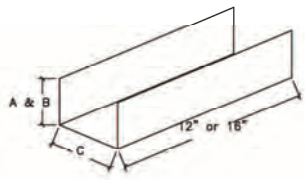
- Base Framing components are illustrated below. They are available in four types and selected based on the existing secondary framing type, spacing and span direction as well as location on the roof.

  1. Eave Bases are used at the roof perimeter for low two-piece eave assemblies. They have unsymmetrical flanges for receiving the Eave Cap shown on the previous page to alleviate minor inconsistencies at the roof edge and provide a horizontally level new eave. Refer to Chapter 10 Eave Framing Conditions for more information.



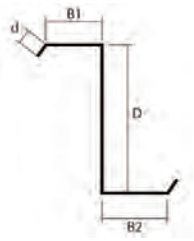
Eave Base – All dimensions in inches					All Materials 16 ga.	
Slope	<1:12	2:12	3:12	4:12	5:12	6:12
Girth	$9^{15}/_{16}$	$9^{15}/_{16}$	$9^{15}/_{16}$	$9^{15}/_{16}$	$9^{15}/_{16}$	$9^{15}/_{16}$
A	$2^{3}/_{4}$	$2^{3}/_{4}$	$2^{3}/_{4}$	$2^{1}/_{4}$	$2^{1}/_{4}$	$2^{1}/_{4}$
B	$3^{3}/_{16}$	$3^{3}/_{16}$	$3^{3}/_{16}$	$3^{11}/_{16}$	$3^{11}/_{16}$	$3^{11}/_{16}$
C	4	4	4	4	4	4
6" Part No.						

  2. Base Shoes are used for receiving vertical cee posts at interior framing locations. They have symmetrical flanges and are available in 12” and 16” lengths to provide either 49.5 or 66 square inches of bearing surface area. The bearing surface area is important for distributing the newly imposed loading into the existing roof substrate and to prevent depressing it after the new retrofit roof is subjected to snow load. See Chapters 4 and 9 for more information.

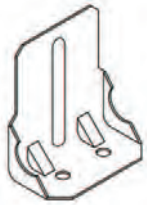


Base Shoe – All dimensions in inches					All Materials 16 ga.	
Slope	<1:12	2:12	3:12	4:12	5:12	6:12
Girth	9 15/16	9 15/16	9 15/16	9 15/16	9 15/16	9 15/16
A	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$
B	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$	$2^{29}/_{32}$
C	$4^{1}/_{8}$	$4^{1}/_{8}$	$4^{1}/_{8}$	$4^{1}/_{8}$	$4^{1}/_{8}$	$4^{1}/_{8}$
12” Part No.						
16” Part No.						

3. Sleeper Zees receive cee posts and are continuous standard LGSI[5] zee-shaped roll formed components. The web dimension (D) can range from 4" to 8" and they also have a stiffening lip (d). They have unsymmetrical flange dimensions (B1 and B2) that permits them to tightly nest together at lapped locations.

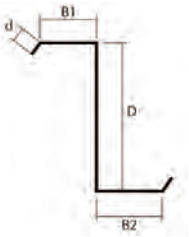


4. Base Clips are stamped steel used for attaching vertical cee posts to the existing roof and it's structural framing. The clips are pre-punched for attachment with self-drilling screws or other type anchors. They are also used at miscellaneous connections for canopies and other special conditions.

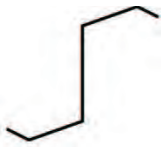


- Vertical Cee Posts are used to support zee purlins and are cee-shaped with return stiffening lips (d). This component is also used at miscellaneous conditions where needed. The web dimension "D" can range from 4" to 8".

- Zee Purlins are LGSI zee-shaped members that attach the vertical cee post with a pitch clip shown below. They have unsymmetrical flange dimensions that permit them to tightly nest together at lapped locations. The web dimension (D) can range from 4" to 8" and they also have a stiffening lip (d).



- Double Sloped Zee Purlins attach directly to the web of vertical cee posts. They are custom fabricated members that have the flanges made to a specific roof pitch up to 4:12. Their web varies in depth from 4" to 8".



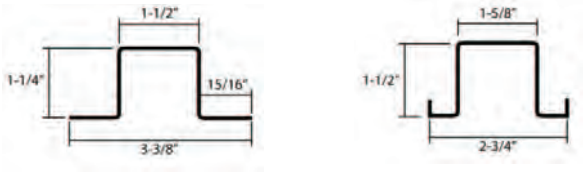
- Drag Strut angles are used for transverse lateral bracing attached to vertical cee posts from eave to ridge or high point of roof framing. Size varies from 2" x 2" to 4" x 6" and spacing is per design.

[5] LGSI - Light Gauge Steel Institute

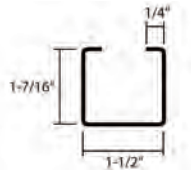
- Rake Angles are located at gable ends and attach to the top of zee purlins. Size is typically 2” x 4” but conditions may require other.

- Pitch Clip is a patent pending angular clip that enables zee purlins to be attached to vertical cee posts at the new roof slope. It is stamped with slope marks that allow the installer to “rotate” the clip from a 1:12 to 6:12 roof pitch.

- Hat Sections are made of galvanized steel and either 1-1/2” x 22 gauge or 1-1/4” x 16 gauge. They are used primarily for girts to receive wall panels located at roof edge elevated eave walls and gable walls. Member selection is per design. The 1-1/4” x 16 gauge hat may be used for struts at double high bracing conditions.

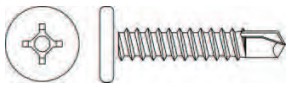


- Channels are galvanized 18 gauge and are primarily used for strut bracing attached to cee posts at those locations requiring double high transverse and longitudinal “X” bracing.



- Structural Fastener - #12-14 x 1” SD N/W self driller without washer for all interior member to member framing connections.

- Structural Fastener - #10-16 x 1” PHD pancake self driller without washer for all perimeter member to member framing connections where metal roof or wall panels will attach.



- Strap Bracing is 1-1/4” wide x .031” thick x 140 ksi banding that is perforated for ease of attaching screws to the cee posts. In some cases, the banding may be used to stabilize purlins to prevent rolling induce by thermal expansion.

Framing Installation

Metal Sales ships framing components on dedicated trucks to the jobsite or other location as requested by the contractor. Components are bundled and banded in like shapes with manufacturing applied identification labels providing the part number/piece mark, quantity and length(s) of members in each bundle. These bundles should be stored with appropriate blocking beneath them to allow water runoff. Accessories, such as screws, clips and miscellaneous items are boxed and should be stored in a safe and secure place protected from inclement weather.

Connections are made with self-drilling fasteners. Attention should be given to the Metal Sales installation documents for type and quantity of fasteners at each connection location. While some contractors will erect the framing by first “fitting” the components using only a few fasteners and then returning to the connections at a later time to complete the fastener installation. It is important to understand that the quantity of fasteners has been determined through engineering calculations and should be strictly complied with to ensure the structural integrity of the retrofit framing assembly

and the contractor's liability in the event of a failure.

As mentioned earlier in this Chapter, most components will require field cutting to their required length(s). In some cases, coping of members may be necessary as well, typically at eave overhangs and special conditions.

It is the contractor's responsibility to ensure that the new roof plane be true to slope and aligned properly. If not, the out-of-plane purlins will cause undue undulation in the new metal roof causing problematic oil-canning issues, panel mis-alignment and possible rejection by the building owner and/or his design professional. To accomplish proper alignment, numerous string lines should be utilized during the installation of vertical posts and zee purlins. String lines should be located from the low eaves to the new roof's ridge or high point, whichever is the case. As well, string lines should be used to locate vertical posts in both directions and each post should be plumbed prior to fastening to their base member and attaching the zee purlins. When zee purlins are installed, they should be lifted and rotated flush with the top flange and the string line, then leveled longitudinally using a stringline that runs from end to end of the purlin. All member to member connections should be tightly clamped prior to installing the fasteners to avoid misplacement.

Beginning on the next page you will find a sequence to the framing installation. To begin with, install low eave framing at their proper elevation above the existing roof. This can be as simple as installing the low eave member to as difficult partially erecting an eave canopy that projects out from the existing roof edge. Next, erect the ridge or the high point cee posts and purlins. This height dimension can be found in the Metal Sales construction drawings. Once the ridge purlins are installed, the plane of the new roof has been established. Then other framing can be installed using the string lines mentioned. If the new roof has hips and valleys, erect a temporary stand at the intersection point with the ridge.

Photo 1 – String Lines Installed at the Intersection of a Hip and Ridge

<u>Erection Sequence and Existing Roof Preparation</u>

Prior to erecting the framing and as mentioned before, it is important to know what makes up the existing roof support system. The existing joists and other members must be located under the roof and then marked in some manner at the existing rooftop. In the photo at the right, an existing roof has been prepared to begin installation of base members by marking their locations. This existing roof is modified bitumen which made it easy for marking. The contractor in this case used fluorescent paint to mark attachment locations as well as the span direction of the existing joists.

In these photos, the contractor is preparing an existing built-up tar and gravel roof by removing and brooming the gravel from the continuous base member locations. Notice the paint marks as well as the string line that has been placed to establish correct alignment of the sleeper zee. Also note shims that have been provided to place beneath the sleeper zees. In some cases, it may be necessary to remove gravel at the attachment location for the shims to fit tight to the existing roof for proper waterproofing. These shims will prevent obstructing the existing roof drainage and damming rainwater on the roof as described in Chapter 4.

This photo shows a sleeper zee after it has been attached to the existing roof joists and after it has been waterproofed to avoid leakage from the anchor penetrations. Waterproofing should be compatible, which is typically a silicone based sealant for single ply roofs and either cold or hot asphalt for built-up or bitumen roofs.

This photo shows a base shoe after it has been attached to the existing roof joists and waterproofed.

Continued on next page

This photo shows a base clip after it has been attached to the existing roof joists and waterproofed.

Beginning with Figure 1 at the right, the illustrations following depict the Retro-Master framing system erection sequence.

Figure 1 shows a required valley condition due to the L-shaped existing roof and a proposed new single slope (monosloped) roof. Since the bar joists are spanning one direction, this will cause the framing assembly to need both perpendicular and parallel conditions requiring two types of base members as indicated in Figure 2 on the next page.

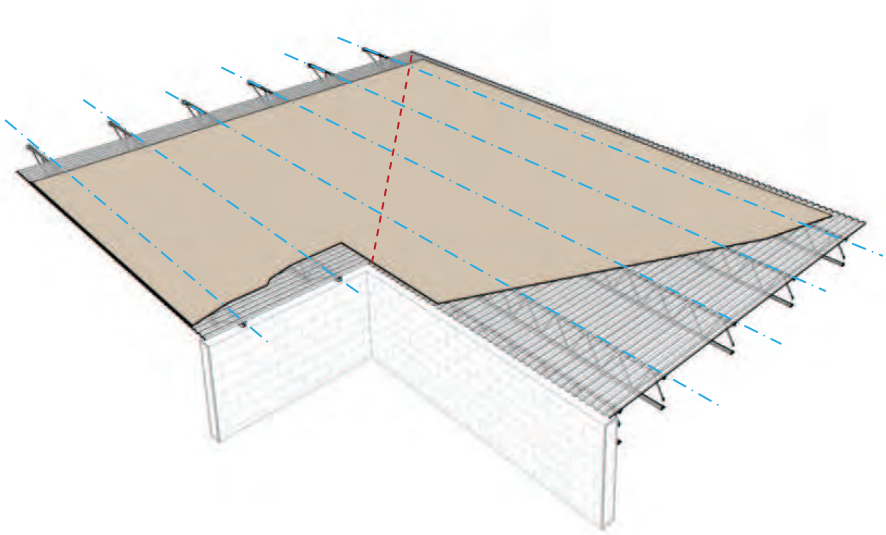


Figure 1 – Existing Roof Layout

Continued on next page

Figure 2 shows the low eave framing member installed with the high point cee posts and purlins. Notice that the interior base shoes and continuous sleeper zee members are installed as well. Note that these can be installed before, during or after the new roof plane is established. The string lines are shown from the low eave to the high points for installing interior cee posts in the field of the roof during the next erection sequence.

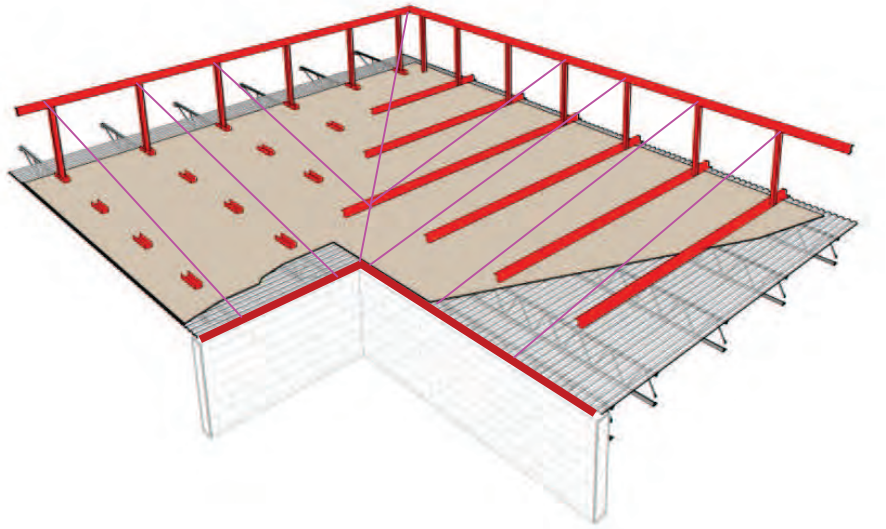


Figure 2 – Installation of Low Eave, High Point Framing and Base Members

Figure 3 shows the installation of interior cee posts. Notice the string lines are still in place to assist in determining the height of each post for field cutting. Once cee posts are installed and plumbed, they are laterally braced both transversely and longitudinally. Note that at valley and hip conditions, a vertical cee posts is to be installed within 1'-0" from the end of each purlin that is terminating at the valley or hip. Depending on the span direction of the existing joists, short sleeper zees, may need to be installed reaching from one joists to the other with the cee post between for support.

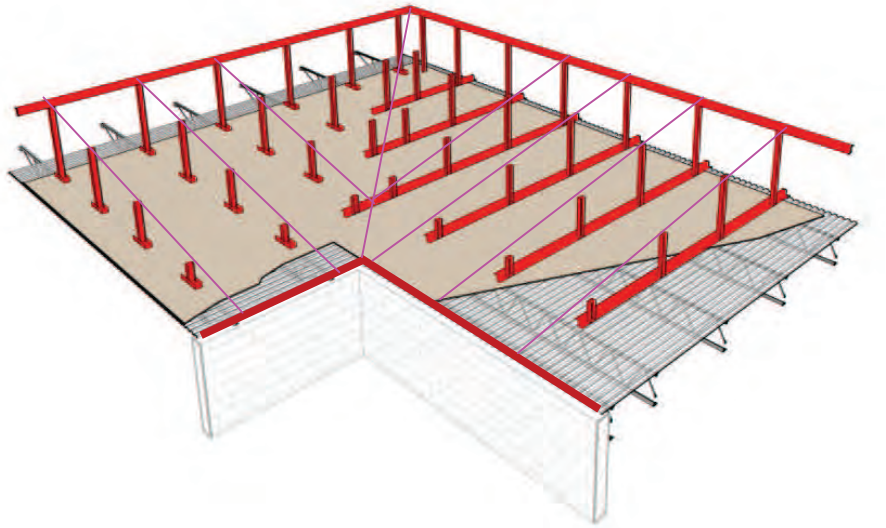


Figure 3 – Installation of Interior Cee Posts

Continued on next page

Figure 4 shows the addition of transverse drag struts and transverse and longitudinal "X" bracing while the string lines are still in place. Note that the cee posts must be plumbed before bracing is installed. The drag struts provide lateral bracing from drag loads. Drag struts vary in size and spacing per design.

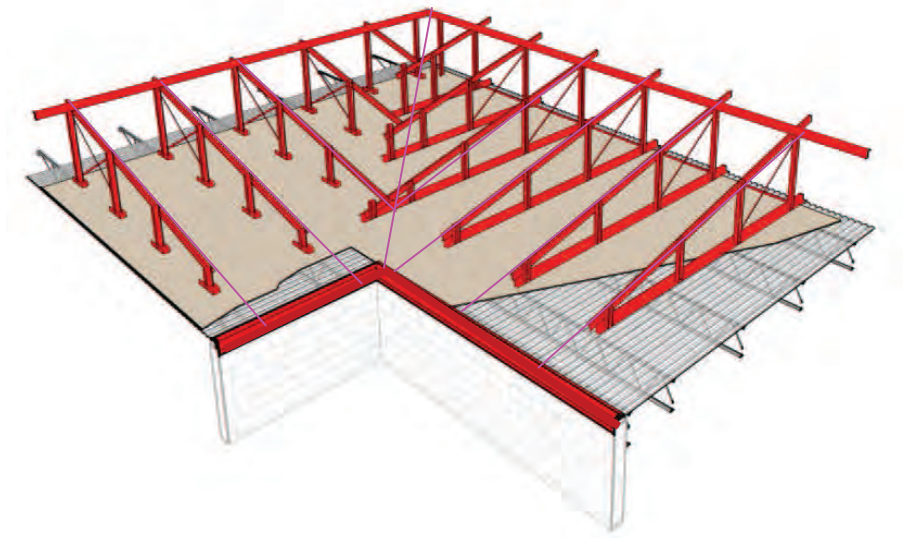


Figure 4 – Addition of Drag Struts and Lateral Bracing

Figure 5 shows the balance of the zee purlins at the interior framing area and the appropriate valley framing that consist of two angles that are placed on top of the purlins with a valley plate installed on the angles. Metal Sales provides many zee purlins cut-to-length except at hips and valleys where they must be field cut to length. It is suggested to utilize string lines from end to end to ensure zee purlin levelness and alignment to new roof plane. Metal Sales provides two methods for attaching purlins to the cee posts. For slopes less than 4:12, a double sloped purlin is provided as shown on page 4 of this Chapter. For greater slopes, special pitch clips are provided as also shown on page 4. Note that this clip can be requested by the contractor for any slope between 1:12 and 6:12.

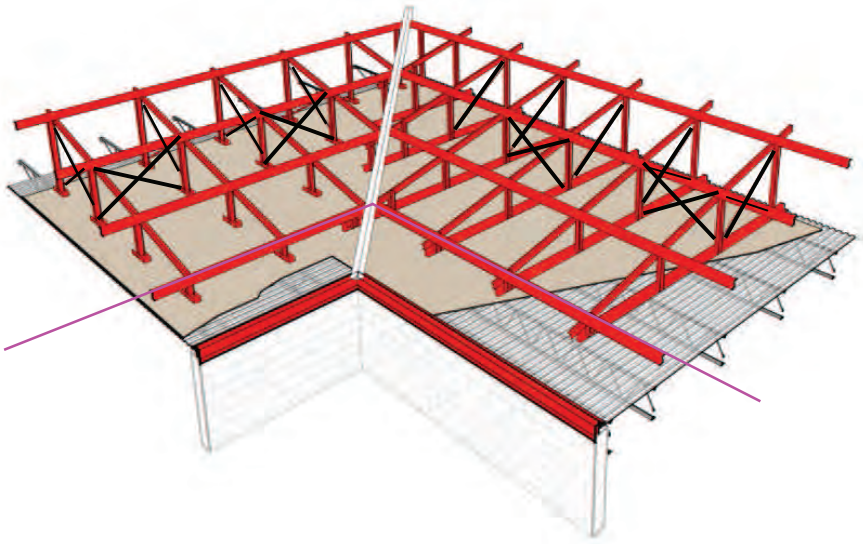


Figure 5 – Addition of Interior Zee Purlins

Continued on next page

Figure 6 shows the final sequence for installing the metal roof, walls and trim. Of course there are other conditions that are addressed during the assembly's installation such as miscellaneous framing for roof penetrations, obstacles at the existing roof level and other issues. If the project is to be insulated, most contractors will install this simultaneously with the metal roof in order to protect it from inclement weather.

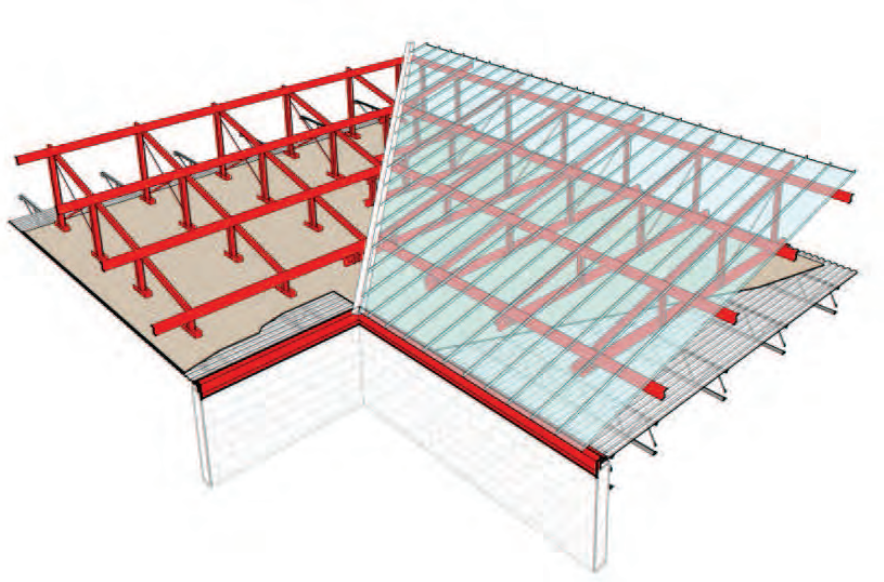


Figure 6 –Installation of the Metal Roof, Walls and Trim

Framing Connections and Anchorage

There are two categories of fasteners in the Retro-Master framing systems. They are member-to-member self drilling screws, which are supplied by Metal Sales. The other category is what should be termed as anchors. These are for attaching base shoes, sleeper zees, variable height zee purlins, all eave bases and clips to the existing roof supports and for attaching low eave framing to the vertical face of the existing wall. These anchors are not provided by Metal Sales and are identified as such in the Retro-Master construction drawings. Refer to Chapter 4 for information on selection, design and how to obtain these anchors.

For member-to-member connections, these should be secured in position by utilizing welder type clamps or other similar devices. Clamping will allow the fasteners to be installed without the framing components slipping, coming out of plumb or level, etc. In many cases, each juncture of two framing members may require the use of two or more clamps. For "X" bracing connections to the cee posts, these also should be clamped once the banding has been tightly put into position. The banding used in these assemblies is 140 ksi high strength steel and normally cannot be penetrated with a self drilling screw. The pre-punched holes provided in the banding permit a fastener to be installed.

Other Framing Conditions

Most retrofit projects are subject to other conditions at the existing rooftop and perimeter edges that will require field preparation and consideration. As well, electrical, mechanical and plumbing equipment will need to be addressed. These will depend on whether they are to be extended to the new roof elevation or to be roofed over. Miscellaneous framing components for these conditions are normally not supplied by Metal Sales unless they are specifically requested by the contractor. The following special framing conditions are provided to assist the contractor during construction.

This photo shows new roof curbs and sub-framing have prepared for exhaust fans to extend through the new roof.

This photo shows how a powered ventilator mounted on a rooftop curb has been framed by the contractor.

This photo shows how an existing rooftop fan and curb have been accommodated due to a conflict with a sleeper zee. This condition is common at existing sanitary vents, furnace flues, skylights and other equipment.

This photo illustrates two things. Access has been provided for future maintenance and replacement of HVAC air handlers that remained on the existing roof. Also the photo shows how these units were framed over.

7 – Performance Specifications

The performance specifications on the following pages are provided to assist design professionals and contractors in creating project construction documents for a Retro-Master™ retrofit over an existing flat roof. For the most current version of these specifications, please visit Metal Sales' website at metalsales.us.com, where they are available for download in an editable MS Word format.

METAL SALES MANUFACTURING CORPORATION GUIDE SPECIFICATION
Section 05 40 00 (05400) – Cold-Formed Retrofit Metal Roof Framing (Version 020113)

Guide Specification for Metal Sales Manufacturing Corporation Retro-Master Retrofit Framing Systems. This guide specification is intended for use on projects where an existing building roof will be retrofitted using a light-gauge steel framing system that creates slope in order to install a new metal roof system. This specification can also be used for new building construction where the steel framing system is installed over new structural concrete deck or structural members.

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Editor Note:

The Construction Specifications Institute (CSI) recommends and supports use of its MasterFormat 2004 section title and numbering system, shown below as SECTION 05 40 00. If using the earlier MasterFormat 1995 section title and numbering designation, the section may be numbered and titled SECTION 05400 as shown in parenthesis (XXXXX).

DISCLAIMER: Use of this Specification is voluntary. Each Retrofit Metal Roof Framing System designer retains the prerogative to choose their own design and commercial practices and the responsibility to design and specify a roofing/wall system to comply with applicable state and local codes, end user specifications, local conditions, and safety considerations. Although every effort has been made to present accurate and sound information, Metal Sales Manufacturing Corporation assumes no responsibility whatsoever for the application of this information to the design, specification or construction of any specific roof/wall system. Metal Sales Manufacturing Corporation expressly disclaims all liability for damages of any sort whether direct, indirect or consequential arising out of the use, reference to or reliance on this Specification or any of its contents. Metal Sales Manufacturing Corporation makes no warranty, express or implied, as to any particular roof/wall system or this Specification. METAL SALES MANUFACTURING CORPORATION specifically disclaims any warranties of merchantability or fitness for a particular purpose.

The notation [Specifier Note:] means that the text following is a specifier's instructional note or sample.

Specifications and Standards
Section 05 40 00 (05400) **- Retrofit Cold-Formed Metal Roof Framing System Guide Specification**

PART 1 - GENERAL

1.01 DESCRIPTION

A. General:
1. The structural Retrofit Metal Roof Framing System will provide support for a new metal roofing system constructed over the existing building roof(s). It shall be engineered in accordance with the specified code and design loading and shall transfer positive acting loads at each attachment location into an existing structural member only. In no case shall the framing be supported by the existing roof decking. The framing shall accommodate inconsistencies in the roof's topography and perimeter geometry to develop a new roof slope plane and will minimize irregularities that could produce oil-canning in the new metal roof system.
2. Contractor to furnish labor, material, tools, equipment and services for the Retrofit Metal Roof Framing System as indicated and specified, in accordance with provisions of the Contract Documents.
3. Contractor to furnish anchoring devices and the design thereof to ensure secure attachment of the Retrofit Metal Roof Framing System to the existing roof's structural support system to resist imposing wind uplift forces.
4. Contractor to furnish components and the design of retrofit framing base member devices to properly distribute imposing loads into the existing roof substrate assembly to prevent being overly compressed once subjected to gravity load, resulting in undulation in the framing system and oil-canning induce stresses into the new metal roof system.
5. Except as otherwise specified, the Retrofit Metal Roof System Manufacturer will provide all components required for a complete single-supplier system assembly including framing base members, clips, purlins, purlin supports, bracing and structural member-to-member fasteners as well as roof/wall cladding, panel clips, trim/flashing, fascias, ridge, closures, sealants, fillers and any other required items as specified in related sections.
6. Completely coordinate with work of other trades.
7. Although such work is not specifically indicated, furnish and install supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
8. See Division 1 (01) for General Requirements.

B. Related work specified elsewhere:
1. Structural steel: Section 05 10 00 (05100).
2. Steel joists: Section 05 20 00 (05200) or 05 40 00 (05400).
3. Metal Roofing: Section 07 41 13 (07410)
4. Metal Walls/Siding and Soffits or Fascias: Section 07 42 13 (07420) or 07 46 00 (07460)
5. Flashing and Sheet Metal: Section 07 60 00 (07600).
6. Insulation: Section 07 20 00 (07200)

[Specifier Note: Delete references to sections not used and add any references that become pertinent. Delete references to MasterFormat Sections shown in parentheses if not used]

1.02 QUALITY ASSURANCE

A. Applicable standards: The following referenced publications shall be the most current edition in effect on the date of bid solicitation.
1. American Institute of Steel Construction (AISC), Chicago, IL
   a. AISC Steel Construction Manual - 13th Edition.
2. American Iron and Steel Institute (AISI)

a. AISI CF00-01, “A Design Guide for Standing Seam Roof Panels”
b. AISI CF97-01, “A Guide for Designing with Standing Seam Roof Panels”
c. AISI “Cold-Formed Steel Design Manual”, 2008
d. AISI S100, “North American Specification for the Design of Cold-Formed Steel Structural Members”, 2007

3. American Society of Civil Engineers (ASCE)
   a. ASCE-7, “Minimum Design Loads for Buildings and Other Structures”
4. Metal Building Manufacturers Association, Inc. Cleveland, OH
   a. “Low Rise Building Systems Manual”, 2012
5. Factory Mutual (if applicable)
   a. FM-4471, “Wind Uplift Test for Metal Roof Panel Systems“
6. American Society for Testing and Materials (ASTM) as applicable
   a. ASTM A 1011, “Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High Strength Low Alloy, High Strength Low Alloy with Improved Formability, and Ultra High Strength”, 2012
   b. ASTM A 653, “Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process”, 2011
   c. ASTM A 792, “Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process”, 2010
7. Steel Structures Painting Council
   a. SSPC- SP10, “Steel Structures Painting Manual”
8. Steel Joist Institute (SJI) (as applicable)
   a. “Steel Joist Institute 60-Year Manual”, 1992-1997 for evaluating existing open-web roof joists
   b. “80 Years of Open Web Steel Joist Construction”, 2009

B. Manufacturer’s Qualifications:
   1. The Retrofit Metal Roof Framing System Manufacturer shall have a minimum of ten years experience in manufacturing retrofit roof framing with metal roofing/wall cladding assemblies. All framing and cladding components specified in this section shall be produced by one Manufacturer in a permanent factory environment with fixed-base roll-forming equipment. A letter from the Manufacturer certifying the Manufacturer’s qualifications shall accompany the product material submittals.
C. Contractor/Installer Qualifications:
   1. Maintain a minimum $250,000 general liability coverage for each loss.
   2. Maintain sufficient worker’s compensation coverage, as mandated by law.
   3. Have no viable claims pending regarding negligent acts or defective workmanship on previously performed or current projects.
   4. Have not filed for protection from creditors under any state or federal insolvency or debtor relief statutes or codes.
   5. Shall be a factory-authorized installer of the Manufacturer trained in the installation of the metal roofing system specified in Section 07 41 13 (07410).
   6. Will provide a full-time project foreman/superintendent at the jobsite that has been trained by the Retrofit Metal Roofing System Manufacturer in the supervision of the installation.
D. Installation Quality Control:
   1. The Contractor shall conduct inspections of the retrofit framing system prior to metal roof panel installation to confirm all components have been installed in accordance with the Manufacturer’s installation documents and to ensure straightness and proper alignment of the new roof purlins and new roof plane(s) for minimizing oil-canning in the new metal roof system.

1.03 EXISTING ROOF SYSTEM AND TESTING

A. Description:
   1. The existing roof assembly consists of a *[Specifier Note: Briefly describe the basic construction of the existing roof structural support system, substrate and membrane assembly. If these vary, you will need*

to expand the description of the multiple roof types. Example: open-web steel bar joists with 22 gauge metal decking, 1-1/2" rigid fiberboard insulation and modified bitumen as the exposed weathering membrane].

2. Refer to the Existing Roof Plan in the Contract Documents for descriptions of varying roof systems, spacing and span direction of existing structural support members, rooftop mounted equipment and other related appurtenances.
3. Where conditions permit and are required, the Contractor shall obtain field measurements to ensure that all design and installation document submittals are coordinated with the Retrofit Metal Roof Framing System Manufacturer. This due diligent work shall be completed prior to commencement of any engineering and design work and before fabrication of any materials.

B. Testing:
1. The Contractor shall conduct field pullout testing for evaluation and selection of framing system anchors to attach the new retrofit framing base members to the existing roof support system. The testing will be conducted using a calibrated pullout tester at multiple locations of the existing roof area not to exceed 1000 square feet each. Pullout values shall be recorded at each location for each specific anchor used. All anchors shall penetrate and attach to existing structural support members. The Contractor shall have the attachment connection designed to satisfy wind uplift values, as provided by the retrofit system Manufacturer, multiplied by a safety factor of 2.5. This analysis shall be submitted for review and approval by the Architect.
2. The Contractor shall conduct field compressive strength testing performed for evaluation of the existing roof substrate and membrane assembly. These values, recorded in pounds per square inch (psi), shall be analyzed by the Contractor to determine if each retrofit framing system base member's bearing surface area is adequate in size, to distribute the imposing positive downward acting loads in order to not exceed the compressive strength of the existing roof substrate and membrane assembly. If the values exceed the compressive strength, then an additional structural bearing device (plate, etc.) of sufficient size will be added between the base member and the existing roof.

1.04 SYSTEM PERFORMANCE REQUIREMENTS

A. Performance Testing:
1. Refer to Section 07 41 13 (07410) for the metal roof system testing requirements. All retrofit framing systems shall be designed in accordance with the specified metal roof testing.

1.05 DESIGN REQUIREMENTS

A. General:
1. The Retrofit Metal Roof Framing and Roof/Wall Cladding shall be designed by one Manufacturer as a complete system. Members and connections not indicated on the drawings shall be the responsibility of the Contractor. All components of the system shall be supplied by the same Manufacturer
2. Pertaining to the existing roof's substrate and assembly, the Contractor shall provide an independent engineering analysis, sealed by a professional engineer, to confirm the existing roof system will not be overloaded and overstressed due to the additional weight or loads imposed as a result of the new Retrofit Metal Roof System. This analysis to be submitted to the Architect and the Retrofit Metal Roof Framing System Manufacturer.

B. Building Code and Design Loads:
1. Design load application shall be in accordance with the latest adopted building code edition of the *[Specifier Note: (Choose only one) IBC, ASCE-7 or an applicable national or local building code].*
2. Deflection requirements shall be in accordance with the applicable building code, or at a minimum L/180 for roof snow load.
3. Dead Loads:
   a. The dead load shall be the weight of the new metal roofing/wall cladding plus insulation if applicable.

4. The collateral loads shall be as shown on the contract drawings. Collateral loads shall not be applied to the roof/wall panels, only to the retrofit framing.
   [Specifier Note: Collateral loads consist of rooftop equipment, sprinklers, mechanical and electrical systems and shall not be solely supported by the new metal roof panels.]
5. Live Loads:
   a. The Retrofit Metal Roof Framing shall be capable of supporting a minimum uniform live load of 20 psf.
6. Snow Loads:
   a. The design ground snow loads shall be as specified on the contract drawings.
   b. Based on the affect of snow loads and drifting loads due to the new Metal Roof System altering the overall final roof geometry, a design examination shall be performed and consideration shall be given to the existing building roof and its support structure in its ability to receive these new loads. Any remedial work necessary to be performed on existing roof's support system to increase the load capacity of the existing structural system, shall be included in the scope of this contract.

   [Specifier Note: All sources of snow drifting should be clearly identified in the contract documents, i.e. adjacent structures, roof height changes, etc.]
7. Wind Loads:
   a. The design wind speed for the Retrofit Metal Roof Framing System shall be as defined on the contract documents.

   [Specifier Note: The design wind speed must be identified as a 3-second gust as appropriate to the applicable code.]
   b. The Retrofit Metal Roof Framing System shall be securely attached only to existing structural support members.

C. Fire Protection:
1. Firestopping, Draft Curtains or other protection in newly created attic space between the old roof and underside of the new roof to comply with the above specified building code and as defined in the contract documents.

D. Existing Roof Drainage:
1. The existing roof drainage system shall be maintained and protected during construction.
2. The Contractor to avoid disrupting and/or blocking any existing roof drains during the erection to prevent rainwater damming and possible overstressing the existing roof system due to the excessive weight of the water.
3. All continuous type retrofit framing base members shall be installed with a 3/8" minimum height shim composed of a non-deteriorating material to elevate the members above the existing roof and to permit rainwater to flow beneath the member.
4. The shim size shall be of sufficient size to accommodate the required minimum square inches necessary to distribute the imposing load as described in above Section 1.03.B.2.

E. Retrofit Framing Components Supporting the Metal Roof System:
1. Any additions/revisions to framing members supporting the Metal Roof System to accommodate the Manufacturer's design shall be the Contractor's responsibility, and shall be submitted for review and approval by the Engineer of Record. New or revised framing members and their connections shall be designed in accordance with [AISC] [AISI] [SJI] design specifications. Deflection requirements shall be in accordance with the applicable building code, or as a minimum, the provisions of the AISC Steel Design Guide Series 3 - Serviceability Design Considerations for Low-Rise-Buildings.
   [Specifier Note: Select design specification for paragraph E.1.]

F. Metal Roof System:
1. Metal Roof System shall comply with Section 07 41 13 (07410) of the Specifications.
2. Metal Roof/Wall Cladding systems shall be manufactured and furnished by the same Manufacturer that is providing the Retrofit Metal Roof Framing System.

G. Accessories and Their Fasteners:

1. Accessories and their fasteners shall be capable of resisting the specified design wind uplift forces.

1.06 SUBMITTALS

A. Installation Drawings:
   1. The Manufacturer to submit complete installation drawings and installation details to the architect (owner) for review. Do not proceed with manufacture prior to review and architectural approval of installation drawings. Do not use drawings prepared by the architect (owner) for installation drawings.
   2. Installation drawings shall show methods of installation, elevations and plans of roof and wall panels, sections and details, specified loads, flashings, roof curbs, vents, sealants, interfaces with all materials not supplied by the Manufacturer, and proposed identification of component parts and their finishes.

B. Calculations (All calculations noted below shall be reviewed and sealed by a Licensed Professional Engineer):
   1. Provided by Manufacturer:
      a. Manufacturer to submit engineering calculations defining cladding loads for all roof areas based on specified building codes, allowable clip loads, and required number of fasteners to secure the panel to the retrofit framing system.
      b. Compute gravity load at each base member attachment to the existing roof system and indicated on installation drawing submittals.
      c. Compute uplift loads on framing system fasteners and indicate on installation drawing submittals.
   2. Provided by Contractor:
      a. Contractor to submit engineering calculations confirming that selected anchoring devices and their quantity thereof will satisfy the Manufacturer's specified uplift loads in the attachment to the existing roof's structural support system.
      b. These calculations shall use a safety factor of 2.5 applied to required ultimate uplift values provided by the Manufacturer.
      c. Calculate holding strength of fasteners in accordance with submitted test data provided by Fastener Manufacturer based on length of embedment and properties of materials.

C. Physical Samples:
   1. None required.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery:
   1. Deliver Retrofit Metal Roof Framing System to job site properly packaged to provide protection against transportation damage.

B. Handling:
   1. Exercise extreme care in unloading, storing and installing system components to prevent bending, warping, twisting and surface damage.

C. Storage:
   1. Store all material and accessories above ground on well supported platforms. Store under waterproof covering. Provide proper ventilation of metal roofing system to prevent condensation build-up between component members.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

A. The retrofit framing and metal roof panel system as specified in sections elsewhere in this specification shall be as manufactured by the following or a prior approved equal with all roof panel, framing components and accessories from a single source Manufacturer.

Metal Sales Manufacturing Corporation - Corporate Office – 545 South 3rd Street, Suite 200 – Louisville, KY 40202
Phone: 800.406.7387 or at www.metalsales.us.com

B. Supply all products specified in this section from the same Manufacturer as for Sections 07 41 13 (07410) and 07 62 00 (07620).

2.02 FRAMING SYSTEM COMPONENTS

A. The retrofit framing Manufacturer shall engineer the framing system to comply with the "Design Intent" of the existing roof's supporting structure to ensure that all new load-bearing or load-transferring members are anchored to and located directly over existing secondary or primary load bearing support members. The retrofit framing system shall consist of any of the following components based on the Manufacturer's design and in accordance with the specifications herewith.
   1. Base clips for purlin supporting member attachment shall be a minimum 3" x 5" x 6" x 16 gauge factory-punched steel angle having 15 in^2 (square inches) of bearing surface area. At the option of the Manufacturer, provide a minimum 14 gauge pre-formed gusseted steel angle base clip that is factory punched for attachment of anchors to the existing roof support system.
   2. Base channel members shall be a 4-1/8" x 3" x 16" long x 16 gauge, having 66 square inches of bearing surface area.
   3. Continuous zee-shaped base members shall be minimum 16 gauge roll-formed steel measuring 4" x 2-1/2".
   4. Channel or cee-shaped purlin supports (vertical members, posts, columns) shall be a minimum 16 gauge roll-formed steel measuring 4" x 2-1/2".
   5. Zee-shaped purlins (horizontal metal roof supports) shall be a minimum 16 gauge roll-formed steel measuring 4" x 2-1/2".
   6. Purlin clips shall be a minimum 16 gauge formed steel angle shape.
   7. Perimeter eave and wall framing members shall be a minimum of 16 gauge formed steel, channel, and cee or custom shapes to satisfy conditions.
   8. Purlin stabilization and transverse or longitudinal strapping shall be a minimum 0.031" thick x 1-1/4" wide x 140 ksi pre-punched steel.
   9. Hat channels used for bracing, girts, struts or other miscellaneous framing members shall be a minimum of 22 gauge steel with galvanized, G90 coating, in accordance with ASTM A 653.

2.03 MATERIALS

A. Steel sheet for roll-formed or press-broke members of the gauge indicated herein, conforming to ASTM A 1011 or ASTM A 653 with minimum yield strength of 55 ksi.
B. Structural shapes, if required for special conditions, shall conform to ASTM A 36 and minimum yield strength of 36 ksi.
C. Cold form steel framing system members of the minimum gauges indicated herein shall have a protective shop primer coating conforming to FS TT-P-646 with base steel prepared in accordance with SSPC-SP10.
D. Supply all hardware items required for installation of retrofit framing system in accordance with Manufacturer's installation instructions and other indicated items.

2.04 MISCELLANEOUS PRODUCTS

A. Fasteners And Anchors:
   1. Anchors used for the attachment of the new retrofit framing system to the existing roof structural support system shall be of the type and size that is appropriate for secure attachment to satisfy the required wind uplift pressure values at each location, as specified by the retrofit system Manufacturer. All anchors shall attach directly into existing structural members. A minimum of two (2) anchors shall be used for base clips and minimum of four (4) for base channels.

2. Fasteners for structural framing connections shall provide both tensile and shear ultimate strengths of not less than 750 pounds per fastener. They shall have a corrosion resistant coating and sized to a minimum ¼" diameter with 14 threads per inch having with a "Stress Relief" head design to prevent screw head overstressing during installation.

B. Anchor Penetration Sealant:
1. Temporary construction sealant shall be used at each anchor penetration at attachment locations of the new retrofit framing system to the existing roof structural support system. The Installer shall select the appropriate sealant type that is compatible with the existing roof membrane, which will provide a leak-free condition throughout the erection of the framing and the completion of the metal roof panel system installation. The installing Contractor is responsible for any and all leaks including damage to the building contents.
2. Insulation, if applicable, to be installed at existing roof to be as specified in Section 07 20 00 (07200).
3. Ventilation of the newly created attic space between the old roof and the underside of the new metal roof to be ventilated.
   a. Design of ventilation system shall yield a minimum intake/exhaust airflow for three (3) air changes per hour.
   b. Refer to Section 07 41 13 (07413) for specified metal roof mounted ventilation as provided by the metal roof Manufacturer.

C. Metal Roof System:
1. Refer to specification section 07 41 13 (07413) for specified metal roof system to be included in the design of and installed on to the retrofit framing system. The following type of metal roof system has been specified.
   a. Structural standing seam metal roof system (SSMRS) capable of spanning over open-framed purlins.
   b. Structural thru-fastened (exposed fastener) metal roof system capable of spanning over open-framed purlins.
   c. Non-structural standing seam metal roof system requiring a solid sub-decking that is supported by the retrofit purlins.

   [Specifier Note: Choose only one of the three types of metal roof systems and delete the others. Coordinate with your Section 07413 roof system that has been specified] NOTE: If option c is selected, you will need to include additional specifications for the roof decking (plywood, metal, etc.)

PART 3 – EXECUTION

3.01 INSTALLATION

3.01 General:
1. Installation shall be as specified and in accordance with the retrofit systems Manufacturer's approved installation documents and erection drawings.
2. Install the retrofit framing system with purlins erected to roof plane without waves, warpage, buckles, fastening stresses or other distortion. Every care should be taken in the installation of the retrofit framing to minimize oil canning in the metal roof panel system.
3. Field cutting of framing members shall be done in a safe manner preventing damage to the existing roof or adjacent materials. The retrofit framing Contractor shall use good construction practices to minimize scrap and to utilize the material as provided by the retrofit system Manufacturer.
4. Dissimilar materials that are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds.

3.02 Erection Tolerances (Over length of member):
1. Variation from plumb: 1/8 inch, maximum
2. Variation from level: 1/8 inch, maximum
3. Variation from true plane: 1/8 inch, maximum

4. Variation from true position: 1/4 inch, maximum
5. Variation of member from plane: 1/8 inch, maximum

3.02 DEMOLITION OF EXISTING ROOF MATERIALS *(if applicable)*

A. The Contractor shall remove existing loose and semi-loose aggregate from any built-up roofing membrane if applicable. Removal shall be accomplished by carefully removing the aggregate in a method that minimizes damage to the roofing membrane. The removal shall be thorough and shall render a semi-smooth substrate suitable for attachment of new retrofit base framing members.

B. The Contractor shall exercise care and shall prevent aggregate from entering roof drains and clogging the existing roof's drainage system. All aggregate surfacing shall be removed and disposed of properly and in accordance with local ordinances and regulations. *[Specifier Note: Include this entire sub-section if all or any part of the existing roof has built-up roof (BUR) and you wish to have any aggregate removed and disposed of. Please note that removal of aggregate will help in compensating for the added weight of the retrofit system to the existing roof]*

3.03 EXISTING ROOFTOP EQUIPMENT

A. General: Additional work may be required to accommodate existing rooftop mounted equipment.
   1. New sub-framing for rooftop equipment being mounted atop new roof shall distribute equipment weight equally to vertical support members and to base members for connection to the existing roof support system.
   2. If any air-handling equipment is to remain at the existing roof level for being roofed over, the Contractor shall inform the retrofit framing Manufacturer of the location and size of the equipment as well any passageway that needs to be provided for future removal and replacement of the equipment.
      a. Manufacturer to accommodate the roofing over existing equipment with framing that provides appropriate clearance over and around the equipment as recommended by the equipment manufacturer.

B. Coordinate work and materials with other trades as necessary.
   1. Existing roof penetrations that are being extended through the new metal roof may require remedial work to ensure that they are routed out between the metal roof's panel ribs. No piping penetrations shall obstruct a panel rib unless the penetration is installed in accordance with the Manufacturer's approved details.
   2. Extension of Electrical Service: When air handling equipment is removed and reinstalled on curbs atop the new metal roof system, the Contractor shall extend the electrical service as required to render the equipment operational. Extensions shall be made with like gauge and type wire. If the original service is run in conduit, conduit shall be installed on the extension. Junction boxes shall be provided at splices in wire or conduits. Junction boxes and conduit shall be secured to the steel framing structure. All work shall be accomplished to comply with the local electrical code.
   3. Extension of Existing Plumbing Vents: During the installation of the specified metal roof panel system, the extension and flashing of existing plumbing vents will be required. The Contractor shall extend existing plumbing vents through the metal roof panels, as required and provide flexible vent pipe flashings at the roof panel penetration. Plumbing vent extensions shall be made with material of like composition of the plumbing vent being extended, and shall be securely braced within the attic space to ensure continued service of the vent. As often as possible, when extending plumbing vents, the Contractor shall ensure that the roof penetration is located between the side seams of the metal roof panels such that the malleable ring on the flexible vent pipe flashing will lay flat against the roof panel around its entire circumference. The Contractor shall install elbow fittings to horizontally displace the pipe if necessary. The metal roof panel system Manufacturer must approve plumbing vents that do not fall between side seams.
   4. Extension of Existing Hot Flue Stacks: During the installation of the specified metal roof panel system, the extension and flashing of existing hot flue stacks will be required. The Contractor shall extend existing hot flue stacks through the metal roof panels, as required and provide flashings at the roof

panel's penetration. Flashings shall be flexible vent stack type or rooftop equipment curb type depending on the size of the existing stack. Hot flue stack extensions shall be of double wall construction made with material of like composition of the hot flue stack being extended, and shall be securely braced within the attic space to ensure continued service of the vent. Hot flue stacks shall be extended to 3 feet higher than the elevation of any roof within a 10 foot radius of the hot flue stack penetration.

5. Extension of Existing Ductwork: When existing gravity vents, power vents, gooseneck fresh air make-up, and other vents are installed on curbs on the new metal roof panel system, the extension of vent ductwork will be required. The Contractor shall extend existing ductwork through the metal roof panel system, as required to ensure the continued service of the vent. Ductwork shall be securely attached to new rooftop equipment curb and joints shall be sealed tight to provide a leak-proof assembly. Ductwork extensions shall be made with material of like composition and gauge of the ductwork being extended.

3.04 REINSTALLATION OF EXISTING ROOFTOP EQUIPMENT

A. During the installation of the specified metal roof panel system, the removal and reinstallation of existing power vents, gravity vents, and gooseneck vents shall be required. The Contractor shall remove and reinstall vents indicated to extend through the metal roof panel system. The Contractor shall have the responsibility to remove such vents without damage, and reinstall the vents on new rooftop equipment curbs. Vents shall be securely fastened to the equipment curb to prevent displacement and to provide a weathertight installation. In the case of power vents, the electrical service shall be extended to ensure continued service of the vent.

3.05 CLEANING, PROTECTION

A. Dispose of excess roofing materials and remove debris from site.
B. Recycle recyclable materials appropriately.
C. Clean work in accordance with Manufacturer's recommendations.
D. Protect work against damage until final acceptance. Replace or repair to the satisfaction of the architect (owner), any work that becomes damaged prior to final acceptance.

END OF SECTION

8 – Metal Panel Systems

This chapter provides the appropriate "fit-for-use" metal roof, wall and soffit panel systems available from Metal Sales™ for use on a Retro-Master™ retrofit project. These panels in this chapter are designed for "open framing" applications, meaning they are capable of satisfying design snow and wind loads spanning from one framing member to its adjacent members. Because of this, they are referred to as structural panel systems.

Panel System Descriptions and Testing

The roof panel systems come in three categories. First is what we term as Commercial/Industrial Panels. These are direct fastened systems and sometimes may be referred to as exposed fastener panels. These come in a range of profiles. Next is Metal Building Panels that are commonly termed as "ribbed" panels. These too are direct fastened systems with. The last category is the most widely used roof systems in the retrofit market; Standing Seam panels. These systems are concealed fastened, meaning they principally do not have exposed fasteners, except in some applications at trim or flashing conditions. Each of these standing seam panels utilize concealed attachment clips that accommodate thermal movement. They allow the panel to expand and contract, inherent with morning to evening panel surface temperature changes. These are high performance systems, each having been laboratory tested in strict accordance to ASTM E 1592[1]. This test has been referred to over the years as the "air bag" test because it measures ultimate negative pressure that the panel assembly can withstand until it fails. The panels are subjected to negative pressure from the bottom side similar to a air bag being filled with air. This test is the standard in the metal roofing industry and is practiced by all manufacturers for their metal roofing product structural performance under laboratory conditions.

Photo 1 – E 1592 test being performed at 150 psf negative pressure

Another testing procedure used in the metal roofing industry is for approval by Factory Mutual, or the FM-4471 test. Two of the listed standing seam roof panel systems have been FM tested and approved up to a Class 1-165. Other testing and approvals for Metal Sales' roof systems are as follows:

- Underwriters Laboratories
- Miami-Dade County
- Florida Building Code
- Texas Windstorm Evaluation

Photo 2 – Typical Metal Sales Standing Seam installation

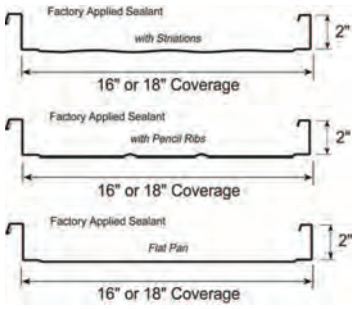
On the following pages, both direct fastened and standing seam roof panel systems are provided with their testing and approvals. Each panel

[1] American Society for Testing and Materials - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference

system also has its intended use in respect to architectural or functional applications, dimensional data and their available gauges. As mentioned in earlier chapters, architectural applications are when the new metal roof is utilized as a design element more so in a building renovation and aesthetic improvement. Functional systems are typically not seen from the ground and therefore are more suited for industrial applications.

Standing Seam Roof Systems

Magna-Loc



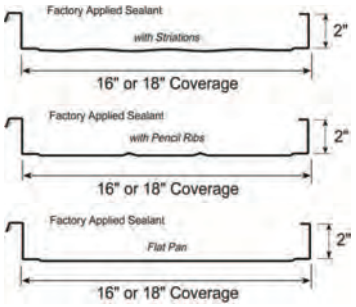
Application & Features

Fit-for-Use: Architectural
2" tall rib mechanically seamed side lap
Available with 90 or 180 degree seams
Coverage: 16" or 18"
Gauges: 24 std. and 22 optional
Minimum roof slope: $^{1}/_{2}$:12
Accommodates $^{1}/_{2}$" to 6" insulation
Finishes: PVDF (Kynar 500®) or Acrylic Coated Galvalume®
Factory applied side lap sealant
Approved for WTW application

Testing & Approvals

- UL 263 Fire Resistance
- UL 790 Class A Fire Resistance
- UL 2218 Class 4 Impact Resistance
- UL 580 Class 90 Wind Uplift
- FM 4471 Class 1-90, 1-105 and 1-165
- ASTM E 1592 Roof Uplift
- ASTM E 1680 Air Leakage
- ASTM E 1646 Water Leakage
- Miami Dade County Approved
- 2010 Florida Building Code Approvals (24 ga over 16 ga purlins)
- Texas Windstorm Evaluation RC-197

Magna-Loc 180



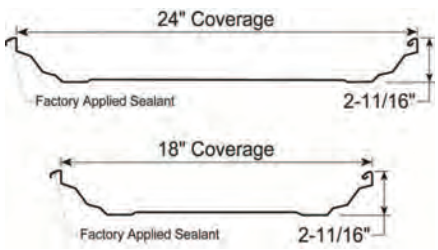
Application & Features

Fit-for-Use: Architectural
2" tall rib mechanically seamed side lap
Available with 90 or 180 degree seams
Coverage: 16" only
Gauges: 24 std. and 22 optional
Minimum roof slope: $^{1}/_{2}$:12
Accommodates $^{1}/_{2}$" to 6" insulation
Finishes: PVDF (Kynar 500®) or Acrylic Coated Galvalume®
Factory applied side lap sealant
Approved for WTW application

Testing & Approvals

- UL 263 Fire Resistance
- UL 790 Class A Fire Resistance
- UL 2218 Class 4 Impact Resistance
- UL 580 Class 90 Wind Uplift
- FM 4471 Class 1-90, 1-105 and 1-165
- ASTM E 1592 Roof Uplift
- ASTM E 1680 Air Leakage
- ASTM E 1646 Water Leakage
- Miami Dade County Approved
- 2010 Florida Building Code Approvals (24 ga over 16 ga purlins)
- Texas Windstorm Evaluation RC-197

Seam-Loc 24®



Application & Features

Fit-for-Use: Functional
$2^{11}/_{16}$" tall pittsburgh double flat locking mechanically seamed side lap
Minimum roof slope: $^{1}/_{4}$:12
Coverage: 18" or 24"
Gauges: 24 std. and 22 optional
Accommodates $^{1}/_{2}$" to 6" insulation
Finishes: PVDF (Kynar 500®) or Acrylic Coated Galvalume®
Factory applied side lap sealant
Approved for WTW application

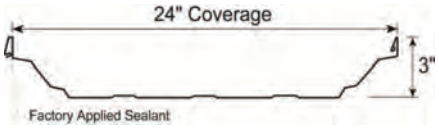
Testing & Approvals

- UL 263 Fire Resistance
- UL 790 Class A Fire Resistance
- UL 2218 Class 4 Impact Resistance
- UL 580 Class 90 Wind Uplift
- FM 4471 Class 1-90 and 1-165
- ASTM E 1592 Roof Uplift
- ASTM E 1680 Air Leakage
- ASTM E 1646 Water Leakage
- 2010 Florida Building Code Approved (24 ga over 16 ga purlins - 18" & 24" wide with and without seam clamps)

Retro-Master™

Standing Seam Roof Systems - Continued

Snap-Loc 24



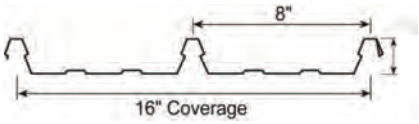
Application & Features

Fit-for-Use: Functional
3" tall snap together side lap
Coverage: 24"
Gauges: 24 std. and 22 optional
Minimum roof slope: 1/4:12
Accommodates 1/2" to 6" insulation
Finishes: PVDF (Kynar 500®) or Acrylic Coated Galvalume®
Factory applied side lap sealant
Approved for WTW application

Testing & Approvals

- UL 263 Fire Resistance
- UL 790 Class A Fire Resistance
- UL 2218 Class 4 Impact Resistance
- UL 580 Class 90 Wind Uplift
- ASTM E 1592 Roof Uplift
- ASTM E 1680 Air Leakage
- ASTM E 1646 Water Leakage
- ASTM E 330 Uniform Static Air Pressure Difference
- 2010 Florida Building Code Approved (24 ga over 16 ga purlins)

Clip-Loc



Application & Features

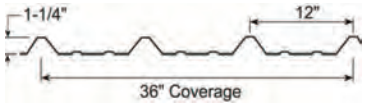
Fit-for-Use: Architectural or Functional
1 5/8" tall Integral snap together side lap
Coverage: 16" (8" rib centers)
Gauges: 24 std. and 26 & 22 optional
Minimum roof slope: 1:12
Accommodates up to 4" insulation
Finishes: PVDF (Kynar 500®) or Acrylic Coated Galvalume®
Approved for WTW application

Testing & Approvals

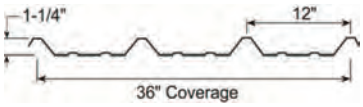
- UL 263 Fire Resistance
- UL 790 Class A Fire Resistance
- UL 2218 Class 4 Impact Resistance
- UL 580 Class 90 Wind Uplift
- UL 1897 Roof Uplift
- ASTM E 1592 Roof Uplift
- ASTM E 1680 Air Leakage
- ASTM E 1646 Water Leakage

Direct Fastened Roof & Wall Panels

PBR-Panel



R-Panel Wall



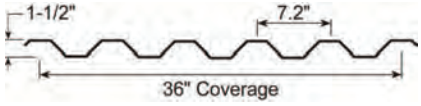
Application & Features

Fit-for-Use: Functional Roof & Wall
1 1/4" tall rib at 12" centers
Coverage: 36"
Gauges: 26 & 24 std., 22 optional
Minimum roof slope: 1:12
Accommodates 1/2" to 3" insulation
Finishes: MS Colorfast45®, PVDF (Kynar 500®) or Acrylic Coated Galvalume®

Testing & Approvals

- UL 2218 Class 4 Impact Resistance
- UL 790 Class A Fire Resistance
- UL 580 Class 90 Wind Uplift
- ASTM E 455 Diaphragm Test
- Miami Dade County Approved (24 ga)
- Texas Windstorm Evaluation RC-198
- 2010 Florida Building Code Approved (26 ga over 16 ga member)

IC72-Panel



Application & Features

Fit-for-Use: Functional Roof & Wall
1 1/2" tall rib at 7.2" rib centers
Minimum roof slope: 1:12
Coverage: 36"
Gauges: 24 std. and 22 & 20 optional
Accommodates 1/2" to 3" insulation
Finishes: PVDF (Kynar 500) or Acrylic Coated Galvalume®

Testing & Approvals

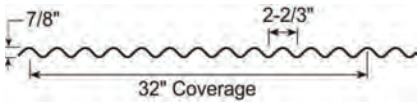
- UL 2218 Class 4 Impact Resistance
- UL 790 Class A Fire Resistance
- UL 580 Class 90 Wind Uplift
- ASTM E 1592 Roof Uplift
- ASTM E 455 04 Diaphragm Test
- ASTM E 283 Air Leakage
- ASTM E 1680 Air Leakage
- ASTM E 330 Uniform Static Air Pressure Difference
- ASTM E 331 Water Penetration
- ASTM E 1646 Water Leakage

Retro-Master™

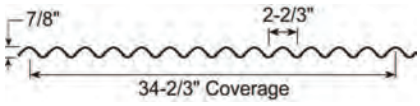
Direct Fastened Roof and Wall Panels - Continued

7/8" Corrugated

Roof



Wall



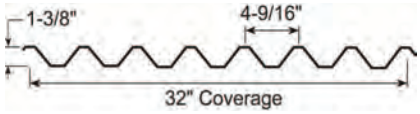
Application & Features

Fit-for-Use: Functional Roof & Wall
$^{7}/_{8}$" tall rib at 2 $^{2}/_{3}$" centers
Coverage: 32" (34 $^{2}/_{3}$" wall)
Gauges: 24 std. and 26, 22 & 20 optional
Minimum roof slope: 1:12
Accommodates $^{1}/_{2}$" to 3" insulation
Finishes: MS Colorfast45®,
PVDF (Kynar 500®) or
Acrylic Coated Galvalume®
Optional materials: stainless steel, aluminum and weathering steel

Testing & Approvals

- UL 2218 Class 4 Impact Resistance
- UL 790 Class A Fire Resistance
- UL 580 Class 90 Wind Uplift
- ASTM E 1592 Roof Uplift
- ASTM E 330 Uniform Static Air Pressure Difference
- ASTM E 283 Air Leakage
- ASTM E 1680 Air Leakage
- ASTM E 331 Water Penetration
- ASTM E 1646 Water Leakage
- 2007 Florida Building Code Approved (24 ga over 16 ga member)

V-Line 32



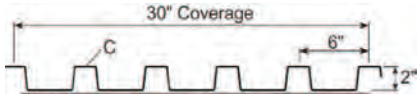
Application & Features

Fit-for-Use: Functional Roof & Wall
1 $^{3}/_{8}$" tall rib at 4 $^{9}/_{16}$" centers
Coverage: 32"
Gauges: 26 & 24 std. and 22 optional
Minimum roof slope: 1:12
Accommodates $^{1}/_{2}$" to 3" insulation
Finishes: MS Colorfast 45®,
PVDF (Kynar 500®) or
Acrylic Coated Galvalume®

Testing & Approvals

- UL 2218 Class 4 Impact Resistance
- UL 790 Class A Fire Resistance
- UL 580 Class 90 Wind Uplift

2" Deep Rib T2630



Application & Features

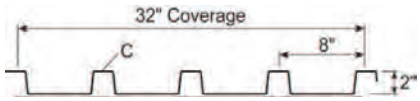
Fit-for-Use: Functional Roof & Wall
2" tall rib at 6" centers
Coverage: 30"
Gauges: 24 std. and 22, 20 & 18 optional
Minimum roof slope: 1:12
Accommodates $^{1}/_{2}$" to 3" insulation
Finishes: standard finish PVDF (Kynar 500®), optional finishes are Multi-pass Kynar 500®, Print Coat Systems, Plastisol and Polyester

Testing & Approvals

Contac Metal Sales for load carrying capabilities, testing and approvals

Optional materials: stainless steel and aluminum

2" Deep Rib T2832



Application & Features

Fit-for-Use: Functional Roof & Wall
2" tall rib at 8" centers
Coverage: 32"
Gauges: 24 std. and 22, 20 & 18 optional
Minimum roof slope: 1:12
Accommodates $^{1}/_{2}$" to 3" insulation
Finishes: standard finish PVDF (Kynar 500®), optional finishes are Multi-pass Kynar 500®, Print Coat Systems, Plastisol and Polyester

Testing & Approvals

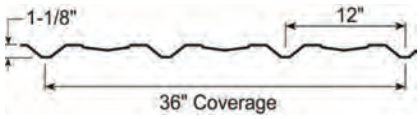
Contac Metal Sales for load carrying capabilities, testing and approvals

Optional materials: stainless steel and aluminum

Retro-Master™

Direct Fastened Roof and Wall Panels - Continued

Span-Line 36A



Application & Features

Fit-for-Use: Functional Wall
1 1/8" rib depth at 12" centers
Coverage: 36"
Gauges: 26 & 24 std. and 22 optional
Finishes: MS Colorfast45®,
PVDF (Kynar 500®) or
Acrylic Coated Galvalume®

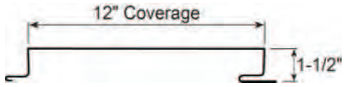
Testing & Approvals

- UL 2218 Class 4 Impact Resistance
- UL 790 Class A Fire Resistance
- ASTM E 330 Uniform Static Air Pressure Difference
- Miami Dade County Approved
- 2007 Florida Building Code Approved (26 ga. over 16 ga. member)

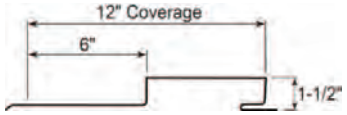
Wall Panels Only

Flush Face – TL Series

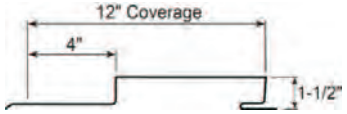
TL-17



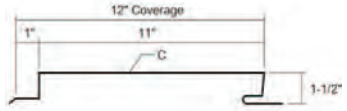
TL-17A



TL-17C



TL-17D



Application & Features

Fit-for-Use: Architectural Wall
1 1/2" depth with 12" coverage
Gauges: 24 std. and 22, 20 & 18 optional
Optional materials: stainless steel, aluminum and weathering steel
Also available perforated
Standard finish PVDF (Kynar 500®)
Optional finishes: Multi-pass Kynar500®, Print Coat Systems, Plastisol and Polyester
Can be used as soffit panel
22'-0" maximum length

Testing & Approvals

Contact Metal Sales for load carrying capabilities, testing and approvals

Flush Face – TLC Series

TLC-1

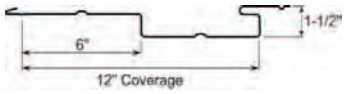
TLC-2

TLC-3

TLC-4

TLC-9

TLC-10



Application & Features

Fit-for-Use: Architectural Wall
1 ½" depth with 12" coverage
Gauges: 24 std. and 22, 20 & 18 optional
Standard finish PVDF (Kynar 500®),
Optional finishes: Multi-pass Kynar500®, Print Coat System, Plastisol and Polyester
Also available perforated
Optional materials: stainless steel, aluminum and weathering steel
Can be used as soffit panel
22'-0" maximum length

Testing & Approvals

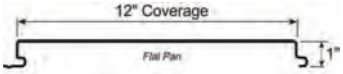
- ASTM E 283 Air Leakage
- ASTM E 331 Water Penetration
- ASTM E 330 Uniform Static Air Pressure Difference

Retro-Master™

Soffit Panels Only

Soffit

Flat Pan



With V-Grooves

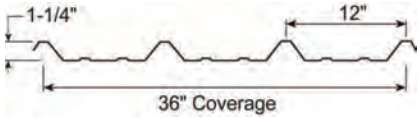
Application & Features

Fit-for-Use: Architectural Soffit
1" depth with 12" coverage
Gauges: 24 std. and 26 and .032" aluminum optional
Finishes: MS Colorfast45®, PVDF (Kynar 500®) or Acrylic Coated Galvalume®
Also available perforated or with louvers

Testing & Approvals

- ASTM E 283 Air Leakage (TLC)
- ASTM E 331 Water Penetration (TLC)
- ASTM E 330 Uniform Static Air Pressure Difference
- 2010 Florida Building Code Approved (24 ga over 16 ga member)

R-Panel



Application & Features

Fit-for-Use: Functional
1¼" tall rib at 12" centers
Coverage: 36"
Gauges: 26 & 24 std., 22 optional
Minimum roof slope: 1:12
Accommodates ½" to 3" insulation
Finishes: MS Colorfast45®, PVDF (Kynar 500®) or Acrylic Coated Galvalume®

Testing & Approvals

- UL 2218 Class 4 Impact Resistance
- UL 790 Class A Fire Resistance
- UL 580 Class 90 Wind Uplift
- ASTM E 455 Diaphragm Test
- Miami Dade County Approved (24 ga)
- 2010 Florida Building Code Approved (26 ga over 16 ga member)
- Texas Windstorm Evaluation RC-198

9 – Reference Information

This Chapter provides information that is related to retrofit roof systems and ends with a metal construction glossary. Table 1 below shows weights of conventional roof system materials that were common over the last several decades. Also included in this Table are thermal resistance values for common building insulation products. This information will help you determine the additional amount of new insulation needed to comply with local energy codes or the Model Energy Code if adopted in your area. Table 2 on the next page provides average insulation R-Values by product type. This information can be confirmed with a local insulation supplier. We have also provided Table 3 on page 3 that lists physical specifications for various series of open web steel bar joists and Table 4 on page 4 that helps you identify joist chord sizes. This data can be very helpful when retrofitting over bar joists in buildings that were constructed many years ago. The chord sizes are needed to establish the center-to-center "gauge" for new retrofit anchors being installed into them when securing the Retro-Master™ framing. Having this information will make it much easier when locating the centerline of the existing joist and placing anchors for retrofit base members to ensure they are installed into the joist's top chords properly. To select proper anchors based on the type of existing structural roof support system, we have provided Table 5 on page 5 that lists commonly used anchors for retrofit applications.

Table 1 - Approximate Weights and Thermal Values of Vintage Roofing Materials[1]

Roofing Component	Material Type	Lbs/SF	R-Value
Roofing Membrane:	EPDM adhered	0.28	0.24
	EPDM ballasted	12.0	0.37
	Modified bitumen	0.25	0.75
	PVC foam (per 1")	0.02	3.85
	3-ply felt	3.00	0.24
	3-ply felt with ballast	5.50	0.33
	5-ply felt	3.50	0.40
	5-ply felt with ballast	6.00	0.55
Decking:	¾" Wood	3.00	0.44
	2" gypsum plank	12.00	1.8
	20 gauge metal	1.50	0.0001
	22 gauge metal	1.25	0.0001
	Lightweight concrete (per 1")	3.0 – 9.0	0.3 - 0.9
Insulation:	Loose fill (per 1")	0.50	2.2 - 3.5
	Poured in place	2.00	6.25
	Rigid (per 1")	0.75	2.78
	Fiberglass batt (per 1")	0.10 – 0.40	4.00
	Tectum (per 1")	0.16	5.56
	Foam board (per 1")	1.75	6.00
Attached or Suspended Ceilings:	Acoustic tile	1.2 – 1.57	2.38
	Suspended	1.40	2.28
	Lath & plaster (per 1")	10.50	0.94

[1] Taken in part from Architectural Graphic Standards, 5th Edition – 1956 Ramsey & Sleeper/John Wiley & Sons, Inc. Publishers

Once the composition of your existing roof assembly has been identified, the preceding material weights and thermal values can help determine the totals needed for the two calculation boxes shown below.

The first calculation box at the right is for estimating the total thermal resistance value (R-Value) of the existing roof assembly. The existing R-Value remains a part of the overall value needed to comply with the energy code. Use this box and the values in Table 1 on the preceding page, to determine the amount of insulation needed for your project by subtracting R-Value (a) from the required local energy code minimum R-Value (b). As explained on the previous page, the energy code requirements will be as adopted by the project's local code authority or at a minimum the U.S. Model Energy Code. For assistance, visit www.energycodes.gov/comcheck to find the local requirements and/or download a government provided software that helps calculate the thermal resistance requirements by building occupancy type.

Estimated Existing Thermal R-Value	
Existing Roof Materials	**R-Value**
Roofing membrane	
Roof insulation	
Roof decking	
Ceiling insulation	
Ceilings	
a = Total R-Value =	
b = Energy Code Min. R-Value =	
R-Value Required (b minus a) =	

Table 2 below provides average R-Values for insulation products common in a retrofit upgrade. A local insulation supplier can also assist in determining the best product for the application whether it is a flat or sloped roof retrofit.

Table 2 – Average Insulation R-Values by Product Type		
Type	**Thickness**	**R-Value**
Unfaced Fiberglass – used for both flat and sloped roof retrofits	2″	7.0
	3.4″	10.0
	3.7″	12.0
	4.3″	13.5
	5.3″	16.5
	6.3″	20.0
Rigid Polyisocyanurate Board – used primarily for sloped roof retrofits.	1″	6.5
	2″	13.0
	3″	19.0
	4″	25.2

The calculation box at the right is for estimating the total weight per square foot of the existing roof assembly for use in the structural engineering analysis as addressed in Chapter 4. This analysis is vital to the safety of the building and its occupants in effort to prevent overloading the roof when adding a new retrofit framing and metal roof system. Analysis calculations should be performed by a licensed engineer. It is important to note that existing buildings may have had interior building finishes added after the original design and construction of the existing roof. These finishes could include the addition of ceilings, mechanical/electrical equipment and fire sprinkler systems as well as any other materials attached or suspended from the existing roof's secondary structural system. For the secondary structural system weight

Estimated Existing Roof Weight Per Square Foot	
Existing Roof Materials	**Lbs/SF**
Roofing membrane	
Roof insulation	
Roof decking	
Secondary structural system (see above)	
Mechanical & electrical (allow 5 lbs/sf)	
Fire sprinkler (allow 5 lbs/sf)	
Ceiling insulation	
Attached or suspended ceilings	
Weight per square foot =	

shown in the calculation box, this relates to roof joists that support the roof decking, insulation and membrane. This weight will have to be calculated based on the type of roof construction, such as wood, steel or concrete. If the roof is supported by open web steel joists, you may refer to Table 3 below for approximate weights per lineal foot (PLF) for some of the more common joists. For others not listed in Table 3, their weights are available from the Steel Joist Institute (SJI) 60-Year Manual, originally published in 1992. The SJI has included reprinted Load Tables in this manual, for all joists manufactured between 1928 and 1988. The manual is available for purchase online at www.steeljoist.org or by calling 843.626.1995.

To confirm that the existing open web steel bar joists have the capacity to support the additional loads to be imposed by the new retrofit framing and metal roof systems, find the approximate weight per lineal foot of the existing joists in Table 3 below and divide it by the joist's spacing. For example, if the joist weighs 8 pounds per lineal foot and the spacing is 5'-0" on center, then the weight per square foot would equal 1.6 lbs.

Joist manufacturing has changed over the years in the advent of improved design and materials. To help you identify your project's joist, understand that most open web steel joists can be identified by a stamped metal tag that is attached at one of their ends. This tag will have the joist series and size (SJ12, etc). Stamped tags are very common unless a tag was inadvertently removed during its initial installation. If the tag cannot be found, then the dimensional data in Table 3 below and 4 on the next page will assist you in identifying S, SJ, J and H series joists by joist depth, web type, and chord size and type. Note that joist sizes and depth may vary throughout the overall roof area. If this is the case, the engineer may want to allow a maximum weight per square foot by using the weight per square foot of the deepest joists. As a matter of interest, depending on the building's geographical location and building code required snow loads, joists are commonly spaced between 4 feet and 6 feet on center. This many differ however if they support additional loads such as roof equipment and suspended construction.

Table 3 – Open Web Steel Bar Joist Information

Joist Series	Manufacture Date	Joist Depths	Approximate Pounds Per Lineal Foot				End Depth	Web Type
			S & SJ	J	H	K		
S, SJ, J, H or K Series	1929 – 1952	8" – 16"	Not Provided				$2^1/_2$"	Round Bar
	1952 – 1972	8"	3.5 - 4.0	4.2	4.2	5.1		
		10"	4.0 - 5.75	4.2 - 6.0	4.2 - 6.1	5.0		
		12"	5.0 - 8.0	4.5 - 8.1	4.5 – 8.2	5.0 - 7.1		
		14"	7.0 -10.0	5.2 - 9.7	5.5 -10.0	5.2 – 7.7		
		16"	8.5 -10.0	6.6 -11.3	6.6 -11.4	5.5 -10.0		
		18"	9.0 -10.5	7.9 -11.3	8.0 -11.6	6.6 -11.7		
		20"	10.5	8.1 -11.9	8.4 -12.2	6.7 -12.2		
		22"	11.5 -12.5	9.6 -11.9	9.7 -12.0	8.0 -13.8		
		24"	13.0	9.9 -12.4	10.3 -12.7	8.4 -16.0		
K Series	1972 - 1988	26"	Not Manufactured			9.8 -16.6		
		28"				11.4 -17.1		
		30"				12.3 -17.6		
L, LA, LJ or LH	1953 - 1988	18" – 48"	Refer to SJI Manual					Angle
[1] DLJ or DLH	1970 - 1988	52" to 72"	Refer to SJI Manual					Angle

[1] Deep Span joists are typically used as primary support girders and not as secondary joists. However, there are buildings with much wider clear spans that use DLJ or DLH series joist girders, typically supported by other joist girders.

Table 4 below provides chord sizes for S, SJ, J and H series joist. What is important about this information is the chord hole gauge shown in the right-hand column. As mentioned above, the hole gauge is the center-to-center of the top joist chords. This dimension is very helpful in properly installing retrofit base member anchors into the joist chords as shown in the photo to the right to ensure a structural connection is secured. In the photo, the screw anchor on the left nearly missed the joist's chord where the one on the right was properly installed near the centerline of the chord.

Photo 1 – Improperly and properly installed screw anchors into existing joist's chord.

Table 4 - Open Web Steel Bar Joist Chord Sizes – Series S, SJ, J and H		
Chord ID	**Top Chord Angle Sizes**	**Chord Hole Gauge (c/c of chords)**
1	$^3/_4$" x $^3/_4$" x $^1/_8$" or 1" x 1" x $^1/_8$"	$1^1/_8$" – $1^3/_8$"
2	1" x 1" x $^1/_8$"	$1^1/_2$"
3	$1^1/_4$" x $1^1/_4$" x $^1/_8$"	$1^7/_8$"
4	$1^1/_2$" x $1^1/_2$" x $^1/_8$"	$2^1/_8$"
5	$1^1/_2$" x $1^1/_2$" x $^5/_{32}$" or $1^3/_4$" x $1^3/_4$" x $^1/_8$"	$2^1/_4$" - $2^1/_2$"
6	$1^1/_2$" x $1^1/_2$" x $^3/_{16}$"	$2^1/_4$"
7	$1^3/_4$" x $1^3/_4$" x $^3/_{16}$"	$2^5/_8$"
8	2" x 2" x $^3/_{16}$" or 2" x $1^1/_2$" x $^3/_{16}$"	$2^7/_8$"
9	2" x 2" x $^3/_{16}$"	3"
10	2" x $1^1/_2$" x $^1/_4$" or $2^1/_2$" x 2 x $^3/_{16}$"	3" – $3^1/_2$"

Anchorage

As we explained in Chapter 4, anchorage of the new retrofit framing system is imperative to a sound design and installation. Choosing the proper anchors, begins with rooftop pull-out testing and using Metal Sales wind uplift requirements as found on the Retro-Master installation documents. This enables an engineer to design the attachments at each base member location to ensure a safe design is achieved and the new retrofit construction will satisfy the minimum design wind uplift requirements. Table 5 on the next page has listed some of the more common anchors that can be obtained from most local fastener distributors. The data in this table is provided by Triangle Fastener Corporation (TFC), which is recognized as one of the major fastener and anchorage distributors nationwide, especially in the retrofit marketplace. To download TFC's retrofit guide, visit trianglefastener.com/retrofitrooffastening.

Table 5 – Data[1] for Commonly Used Anchors For Retrofit Roof Applications				
Existing	**Manufacturer Designation**	**Diameter - Threads per inch**	**Available Lengths**	**Pullout Value[2] (LBs)**
Attachment to Wood				
2" x Pine[3]	Concealor® Pancake Head Screw	#14-13	1½" to 9"	991
2" x Fir[3]	Triangle Fastener Tapper Type A	1/4"	up to 6"	991
	Common Lag Screw	5/16"	up to 6"	172 -1169
		3/8"	up to 12"	186 -1330
		1/2"	up to 24"	191-1609
Attachment to Concrete				
Concrete[4]	Sentry Plus Five® Roofing Screw	#14-13	1 1/4" to 12"	740
		#15-13	1 1/4" to 24"	1002
	Zamac Drive Pin	3/16"	7/8"	500
		1/4"	3/4" to 2"	580 -1150
	Spike® Nail-in	1/4" (1 1/4" Embed)	2" to 14"	820 - 5460
	Tapcon® Threaded Screw	1/4" (1 1/4" Embed)	1 1/4" to 6"	1050
		1/4" (1 1/2" Embed)		1380
		1/4" (1 3/4" Embed)		2020
Attachment to Steel[5]				
14 Gauge	Concealor® Pancake Head Screw	1/4"-14 DP3	1 3/8" to 6"	1077
12 Gauge				2170
1/8"				2030
1/4"				4493
3/16"	Blazer® Drill Screw Hex Washer Head	1/4"-14 DP3	3/4" to 8"	3863
1/4"				4493
3/8"		1/4"-20 DP5	3" to 8"	4283
1/2"				4680

[1] Data is provided by Triangle Fastener Corporation (TFC) manufacturer's literature and testing. Visit www.trianglefastener.com for more information or call 800.486.1832 for assistance TFC does provide assistance with jobsite pull-out testing and evaluation. PLEASE NOTE: Metal Sales does not supply anchors/fasteners for anchoring the Retro-Master framing system to the existing building.

[2] Average ultimate value in pounds with no safety factors applied. Where a range is provided, the ultimate pullout value is totally dependent on the actual condition of the material being attached to.

[3] Fastener with full penetration (greater than 1") into wood member. Consult with Fastener Manufacturer or distributor for minimum requirements.

[4] Concrete based on 3,000-psi minimum with manufacturer specified embedment. Tapcon anchors based on 3,145-psi concrete.

[5] Most Bar Joist chord thicknesses range from 1/8" to 1/4" per Table 4 on page 4. If existing roof is supported by structural steel beams, fasteners can accommodate thicknesses up to 1/2"

Metal Construction Glossary

Accessory: An extra building product which supplements a basic solid sheeted building such as door, window, skylight, ventilator, etc.

(ACG) Acrylic Coated Galvalume®: Improved surface corrosive resistance.

Adequate Support: The existing roof covering possesses sufficient compressive strength to resist the downward post reactions.

Aging: Changes in physical and mechanical properties that occur when a material is stored for some time. Aging is also accelerated by exposure to elevated temperatures or UV rays.

Aluminum: A silver-white metallic element. It is used to form corrosion-resistant, roof panels.

Anti-Siphon Groove: A break in the closeness of materials at a panel sidelap that is designed to avoid capillary action by allowing water to drain.

Architectural Panel: Intricately formed panel with special attention given to its appearance.

Backer: A coating applied to the back side of the coil material.

Barrel Roof: Roof shape following a circular arc along one dimension.

Base Angle: An angle secured to the perimeter of the foundation to support and close wall panels.

Base Trim: Z-shaped trim designed to close off opening at base of wall around perimeter of building.

Bay: The space between frame center lines or primary supporting members in the longitudinal direction of the building.

Bevel Cut: To cut a panel at an angle other than 90°.

Building Code: Regulations established by a recognized agency describing design loads, procedures and construction details for structures. Usually applying to designated political jurisdiction (city, county, state, etc.).

Camber: The deviation of side edge from a straight line, the measurement being taken on the concave side with a straight edge.

Canopy: Any overhauling or projecting root structure with the extreme end usually unsupported.

Cantilever: A projecting beam segment that is supported and restrained at one end only.

Capillary Action: The force that causes a liquid to be raised between close vertical surfaces.

Chalking: A process by which finishes develop a loose powdery surface resulting from decomposition of the binder. It occurs, principally, through the action of ultraviolet rays.

Clerestory: An outside wall that rises above an adjoining roof planes.

Clip: Component of a standing seam roof that connects the roof panel to the structure.

Closure Strip: A resilient strip, formed by the contour of ribbed panels used to close openings created by joining metal panels and flashing.

Column: Vertical support member for main framing system.

Condensation: The process by which a vapor loses heat and changes into a liquid.

Coping: A flashing cap covering the top course of a wall.

Copper: A reddish metallic element used for roof covering and flashings. Copper is a dissimilar material to a zinc, aluminum and steel.

Coverage: The actual length of a panel after installation.

Cricket: Flashing arrangement with ridge and valleys used to prevent standing water where a low side of roof meets a vertical wall i.e. chimney, curb.

Dead Load: The weight of all permanent construction, such as supported floors, roof, framing and covering member.

Design Loads: Those loads specified in building codes published by Federal, State or City agencies, or in owner's specifications to be used in the design of a building.

Diagonal Bracing: An arrangement of structural materials diagonal to the primary structure to add lateral stability.

Diaphragm Action: The resistance to racking generally offered by the covering system.

Direct Fastened Panel: A panel system that is attached to the building structure via exposed fasteners passing through the roof panel and into the building structure.

Downspout: Rectangular and/or round tube used to channel water from gutter.

Dormer: A vertical surface (i.e. window) that is set vertically on a sloping roof. The dormer has its own roof, typically creating a ridge and valleys.

Drag Load: The component of a gravity load tending to slide a panel off of a sloped roof plane.

Eave: The line along the side wall formed by the intersection of the faces of the roof and wall panels.

Eave Height: The vertical dimension from finished floor to the eave.

Eave Strut: A structural member at the eave to support roof panels and wall panels. It may also transmit wind forces from roof brace rods to wall brace rods.

Eave Trim: L-shaped trim designed to close off top of sidewall panels. It also can be used to close off ends of soffit sheets.

Embossing: The process of decorating, or covering with design, by depressing the surface of the metal strip using a patterned or "coining" roll.

Expansion Joint: A break or space in construction to allow movement of the materials used in the structure.

Fabrication: The manufacturing process performed in a plant to convert raw materials into finished metal building components. The main operations are cold forming cutting, punching, welding, cleaning and painting.

Fascia: A decorative trim or panel projecting from the face of a wall.

Flashing: A sheet metal closure which functions primarily to provide weather tightness in a structure and secondarily to enhance appearance.

Flatness: A measure of a sheet's ability to conform to a flat horizontal surface. Maximum deviation from that surface is the degree to which the sheet is out of flat.

Fluorocarbon Coatings: Thermoplastic coatings based on resins made by polymerizing polyvinyl fluoride, or PVDF (polyvinyldene fluoride).

Footing: A pad or mat, usually of concrete, located under a column that is used to distribute the loads from that member into the supporting soil.

Frame: Primary structural support members that support the secondary framing.

Framing: The primary and secondary members (columns, rafters girts, purlins, brace rods, etc.) which go together to make up the skeleton of a structure to which the covering can be applied.

Gable: The vertical triangular end of a building from eave to ridge.

Galvalume®: A proprietary trade name for a coating, used over sheet steel that is composed of an aluminum-zinc alloy for corrosion resistance. The alloys that make up the coating are aluminum (55%) and zinc (45%). Also referred to in the marketplace as Zinc-Aluminum, Zincalume and Aluminum-Zinc.

Galvanized: Steel coated with zinc for corrosion resistance. G90 indicates the zinc weight of 0.90 ounces per square foot.

Gauge: Thickness of steel or distance between holes punched or drilled in flanges.

Girt: A secondary horizontal structural member attached to sidewall or endwall columns to which wall covering is attached and supported horizontally.

Gutter: A channel member installed at the eave of the roof for the purpose of carrying water from the roof to the drains or downspouts.

Gutter End Closure: Metal insert provided with sealant and fasteners to close end of eave gutter.

Header: A horizontal framing structural member over a door, window or other framed opening.

Header and jamb flashing: Flashing designed to cover red iron frame around a framed opening.

Hemming: The bending of the end of a panel to accept the offset cleat or extended eave.

Hip Roof: A roof which rises by inclined planes from all four sides of a roof.

Hot Rolled Products: Steel deoxidized by silicon or aluminum to reduce the oxygen content in the molten steel to a minimum prior to solidification of the metal. Killed steels have more uniform properties and chemical composition than other types.

Hylar 5000: See Kynar 500/Hylar 5000.

Ice Dam: A buildup of ice caused by melting snow that runs down to an obstruction and refreezes on the roof.

Inadequate Support: The existing roof cover does not possess sufficient compressive strength to resist the downward post reactions.

Insulated panel: Interlocking panels composed of two formed sheets with insulation between.

Insulation: Any material used in building construction to reduce head transfer.

Inside Corner Trim: Trim designed to flash inside corners.

Jamb Trim: A trim used vertically on each side of a framed opening to trim off edge of sheeting.

Jamb: Vertical framing members that frame openings in walls.

Kick-Out (Elbow): (Turn-Out) A lower downspout section used to direct water away from a wall.

Kynar 500®/Hylar 5000®: Brand names for the two common resin used in Fluorocarbon paints. “Kynar” paints are produced under license from Atochem or Ausimont, respectively. These paints are sometimes referred to as 70% Kynar and 50% Kynar. Due to the practice of diluting the Kynar with acrylic resin to make it less expensive - hence 50% Kynar.

Lean-To: A structure such as a shed, having only one slope or pitch and depending upon another structure for partial support.

Live Load: Transient downward acting occupancy loads exerted on a roof, but not dead, wind or seismic loads.

Liner Panel: A metal panel attached to the inside of the girts, or to the inside of a wall panel.

Loads: Anything that causes a force to be exerted on a structural member. Examples are: (a) Dead Load, (b) Impact Load, (c) Roof Live Load, (d) Seismic Load, (e) Wind Load, (f) Crane Load, (g) Collateral Load.

Mastic: Caulking or sealant furnished in rolls, normally used on sealing roof panel’s laps.

Mechanically Seamed: The closing or joining of two parts via a mechanical device.

Mil: A unit of measure equal to 0.001-inch. It is used to describe film thickness.

MS Colorfast45®; SMP (Modified Silicon Polyester Coatings): Thermosetting coatings based on the product of the reaction between an organo-siloxane-intermediate and a suitable polyester resin. Cross-linked with amino or epoxy resins.

Multi-span Building: Buildings consisting of more than one primary framing span across the width of the building. Multiple gable buildings and single gable buildings with interior posts are examples.
Non Structural Panel: A panel system that requires a continuous support not spaced supports.

Net Free Area: Open area of venting material measured in square inches per foot of material.
Oil Canning: A dished distortion in a flat or nearly flat surface.

Oiled: Application of a suitable rust-preventive oil to flat rolled steel to retard rusting during shipment and storage. It is also desirable in reducing friction.

Panel: A sheet of roof material manufactured to connect to adjacent panels, attach to support framing and provide the weather protection layer of the building envelope.

Parapet: That portion of the vertical wall of a building which extends above the roof line at the intersection of the wall and roof.

Peak: The uppermost point of a gable.
Peak Cap: Prefabricated trim piece that trims rake fascia connection at peak of gable.

Pitch Clip: A structural support connector used in retrofit roofing, to attached purlins to posts.

Plastisol Coatings: Thermoplastic coatings consisting of pigmented dispersions of finely divided polyvinyl chloride resins in suitable plasticizers. Curing the baking process the resin particles are solvated by the plasticizer and fuse to a continuous film.

Polyester Coatings: Thermosetting coatings based on the condensation products of polybasic acids and diols (dihydric alcohols). Generally cross-linked with amino resins.

Post: A vertical structural member extending from the existing roof to the new roof plane.

Primer Paint: The initial coat of paint applied in the shop to the structural framing of a building for protection against the elements during shipping and erection.

Pull Out: The amount of force needed to pull a fastener directly out of a substrate. See page 9-5.
Pull Over: The amount of force required to pull a material over the head of a fastener.

Purlin: A secondary structural member located in the roof that directly supports the roof panel and is in turn supported by the primary structural framing. They usually span from post to post.

PVDF: See Kynar 500/Hylar 5000.

Rake: The intersection of the plane of the roof and the plan of the gable wall.

Rake Fascia: A flashing designed to close the opening between the roof and gable wall.
Retrofit: The placing of new metal roof or wall systems over deteriorated roof or walls.

Ridge: Apex of building.

Ridge Cap: A transition of the roofing materials along the ridge of a roof, sometimes called ridge roll or ridge flashing.

Roll Forming: An operation used in forming metal strip. The metal is run progressively through rolls of definite setting that bend the strip to a final predetermined contour.

Roof Pitch or Slope: Degree of slope in roof. Expressed in inches of rise to 12 inches of run.

Roof Extension: Cantilevered continuation of roof at rake line.

Roof Overhang: A roof extension beyond the endwall/sidewall of a building.

Roof Seamer: A mechanical device used to join two adjacent metal roof panels to a hold down clip, together forming a weather tight and structural joint.

R-Value: A measure of the resistance of an insulating or building material to heat flow. Expressed as R-6, R-13 and so on.

Sag Angle: Small angle used to help reduce sag in purlins and girts in bolted building.

Salt Spray Tests: An accelerated corrosion test in which the metal specimens are exposed, either continuously or intermittently, to a fine mist of salt water.

Sandwich Panel: A panel assembly used as covering. It consists of an insulating core material with interior and exterior metal skins.
Sealant: Any material which is used to close up cracks or joints to protect against leaks.

Secondary Framing: That framing which consists of minor load carrying members of a structure, such as purlins, girts struts, etc.

Self Drilling Screw: A fastener which combines the functions of drilling and tapping. It is used for attaching panels to purlins and girts.

Self Tapping Screw: A fastener which taps threads in a predrilled hole. It is for attaching panels to purlins and girts and for connecting trim and flashing.

Shim: Thin piece or pieces of material used to fill small voids or gaps between materials.

Sill: The bottom horizontal framing member of an opening such as a window or door.

Single Slope: A sloping roof with one surface. The slope is from one wall to the opposite wall or a rectangular building.

Skylight: Translucent panel used on roof or walls in place of certain rib sheets to supply natural light to building.

Sleeper: A structural member that distributes loads from a line of posts onto the existing framing members that are not aligned with the posts.

Snap Together Seam: A panel system attached to the building structure via concealed clips or nail strip. The snap mechanism is an interference fit that resists disengagement. This system is not mechanically seamed or direct fastened.

Snow Load: A load imposed on buildings or other structures due to snowfall.

Soffit: The underside covering of any exterior portion of a metal building roof extension.

Solar Reflectance: The ratio of the reflected solar energy to the total solar energy arriving at the roof surface.

Span: The distance between supports of beams, girders or trusses.

Specifications: A statement of particulars of a given job, as to size of building, quality, and performance of mean and materials to be used, and the terms of the contract. The most common specification found in the metal building industry is the "Recommended Guide Specifications for Pre-Engineered Metal Buildings," published by the Metal Building Manufacturers Association.

Standing Seam: A panel system that is attached to the building structure via concealed clips while accommodating thermal movement of the roof panels. This system may be mechanically seamed or snap together.

Stitch Screw: A fastener used to connect panels at the side lap and trims.

String Line: A construction method that creates a working line between two established points using a taut string.

Strippable film: A coating applied over the topcoat to protect the finish during fabrication, transit and erection. EXTENDED EXPOSURE TO SUNLIGHT MAKES REMOVAL OF THE FILM VERY DIFFICULT.

Structural Panel: A panel system that may be applied over spaced supports. Continuous sheathing is not required.

Structural Quality: Sheet of this quality should be specified when the strength of the finished part, usually in load bearing structures, is of importance and the mechanical properties required in the steel sheet must be specified.

Strut: A brace fitted into a frame work to resist force in the direction of its length.

Tensile Strength: The longitudinal pulling stress a material can bear without tearing apart.

Tension Leveling: A mechanical operation wherein sheet steel in coil form is passed through a unit which stretches the product beyond its yield point. The purpose is to provide a sheet with superior flatness characteristics.

Thermal Emittance: The ratio of radiant energy released to that of a standard black body.

Thermal Expansion: The expansion of panels and flashings due to heat, usually caused by direct sunlight.

Tolerance: Specified limits of deviation from a dimension.

Trim: The light gauge metal used in the finish of a building, especially around openings and at intersections of surfaces, often referred to as flashing.

Truss: A structure made up of three or more members, with each member designed to carry a tension or compression force. The entire structure in turn acts as a beam.

Uplift: Wind load on a building which causes a load in the upward direction.

Valley: The sloped intersection at two roof planes along their low edge.
Ventilator: An accessory usually used on the roof that allows air to pass through.

Wash Coat: See Backer.

Wainscot: Sheeting or liner panel on the inside of a building that goes from floor to girt and is below eave height (not full height).

Wind Load: A load caused by the wind blowing from any horizontal direction.

Yield Strength: The stress at which a member will deform but not return to its original shape when the load is removed.

Zinc: A white element, it is used primarily as a coating on sheet to provide corrosion resistance. It is also used as a high end roof covering material.

10 - Standard Details

Retro-Master™ standard construction details are provided on the following pages. These details illustrate the system components in an installed assembly with member and connection fastener callouts. Note that the quantity of some fasteners are identified on a project by project basis and are subject to design verification. These details are not to be used for construction unless Metal Sales™ has first approved them for a specific project and the specified design loading.

Retro-Master Framing Exclusions

The following identifies specific exclusions of framing components and accessory items that are not provided by Metal Sales. Other exclusions may be specific to a project. Refer to the Metal Sales Estimate Quotation for more information.

- All framing anchors at existing roof and walls
- Framing shims or bearing plates
- Curbs
- Curb framing unless requested by contractor
- Aluminum framing
- Temporary shoring
- Framing for temporary setting of roof planes

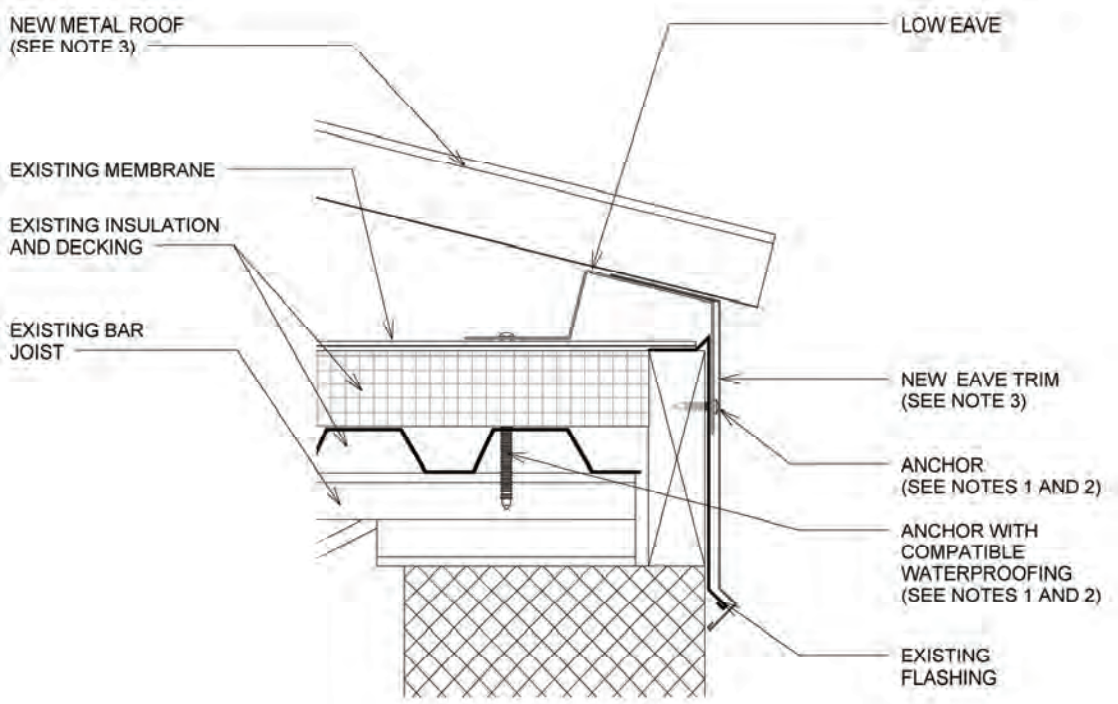
Continued Next Column

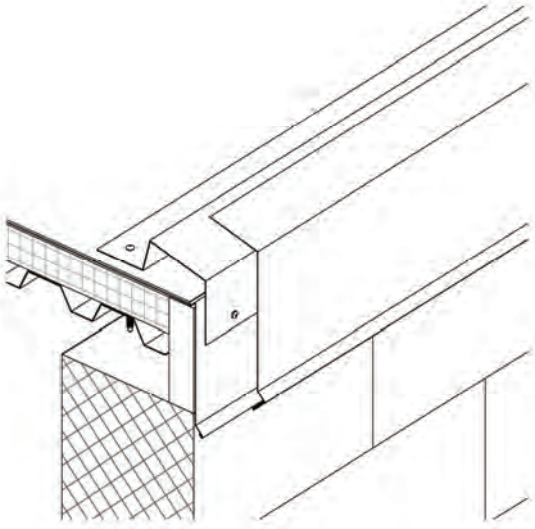
Continued Next Page

Refer to Chapter 6 for framing component details, dimensions and other information pertaining to connections and use in the Retro-Master framing system assemblies.

Details of member type, spacing and quantity are per design. They are standardized details and are not appropriate for all retrofit projects and should only be used in preliminary documents and not for construction without first discussing with a local Metal Sales representative. Metal Sales reserves the right to utilize other methods during the engineering and project review.

These details are subject to change without notice. For the most current versions, visit the Metal Sales website at www.metalsales.us.com.

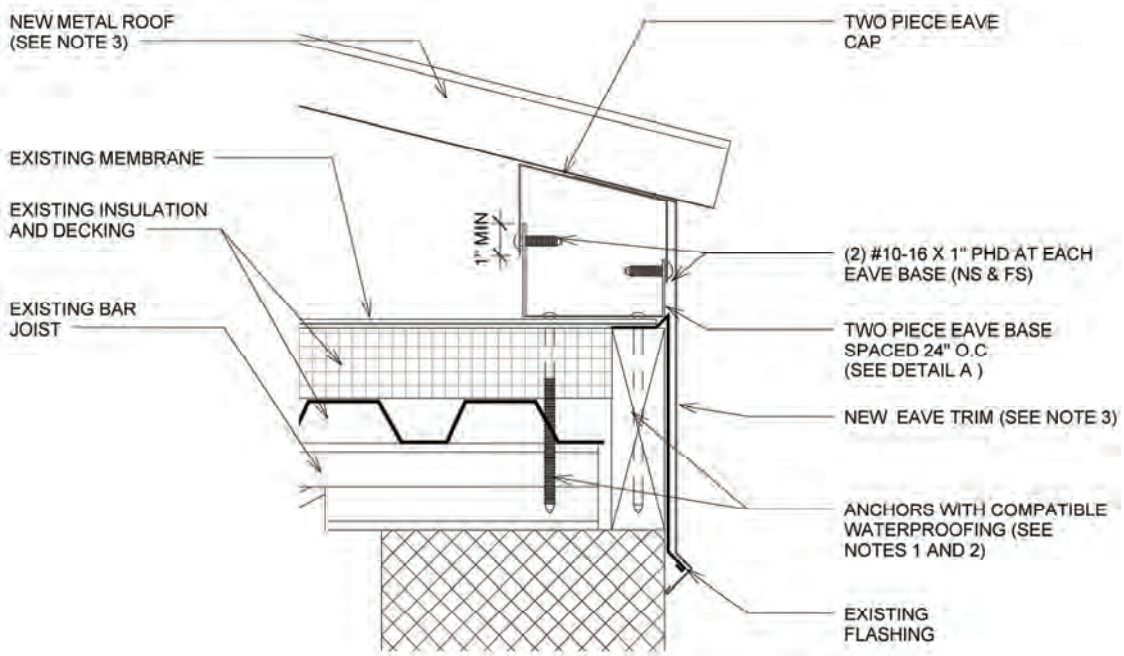


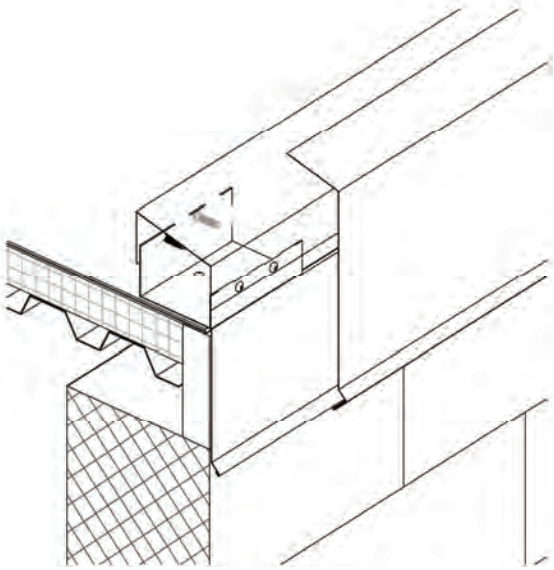


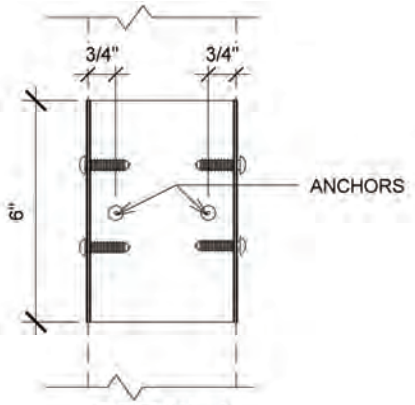
NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT

metal sales manufacturing corporation	Date 5/15/2013	Low Eave





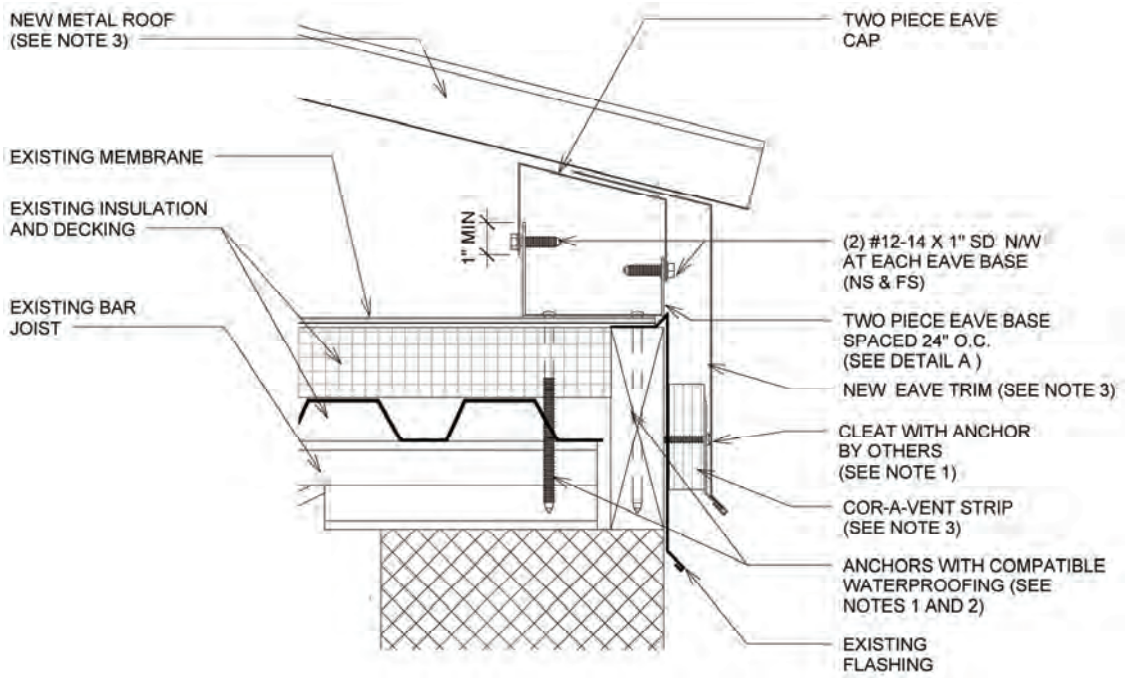


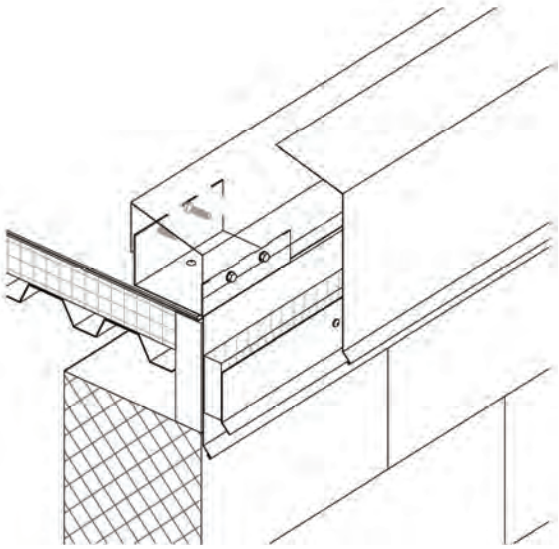
DETAIL A

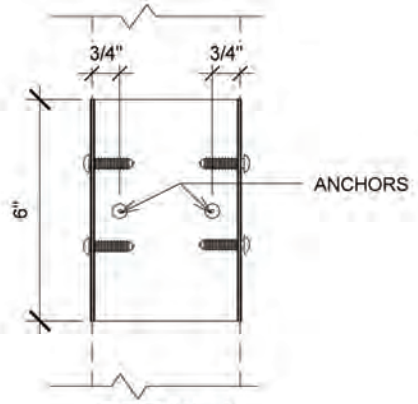
NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT

metal sales manufacturing corporation	Date 5/15/2013	Low Two Piece Eave





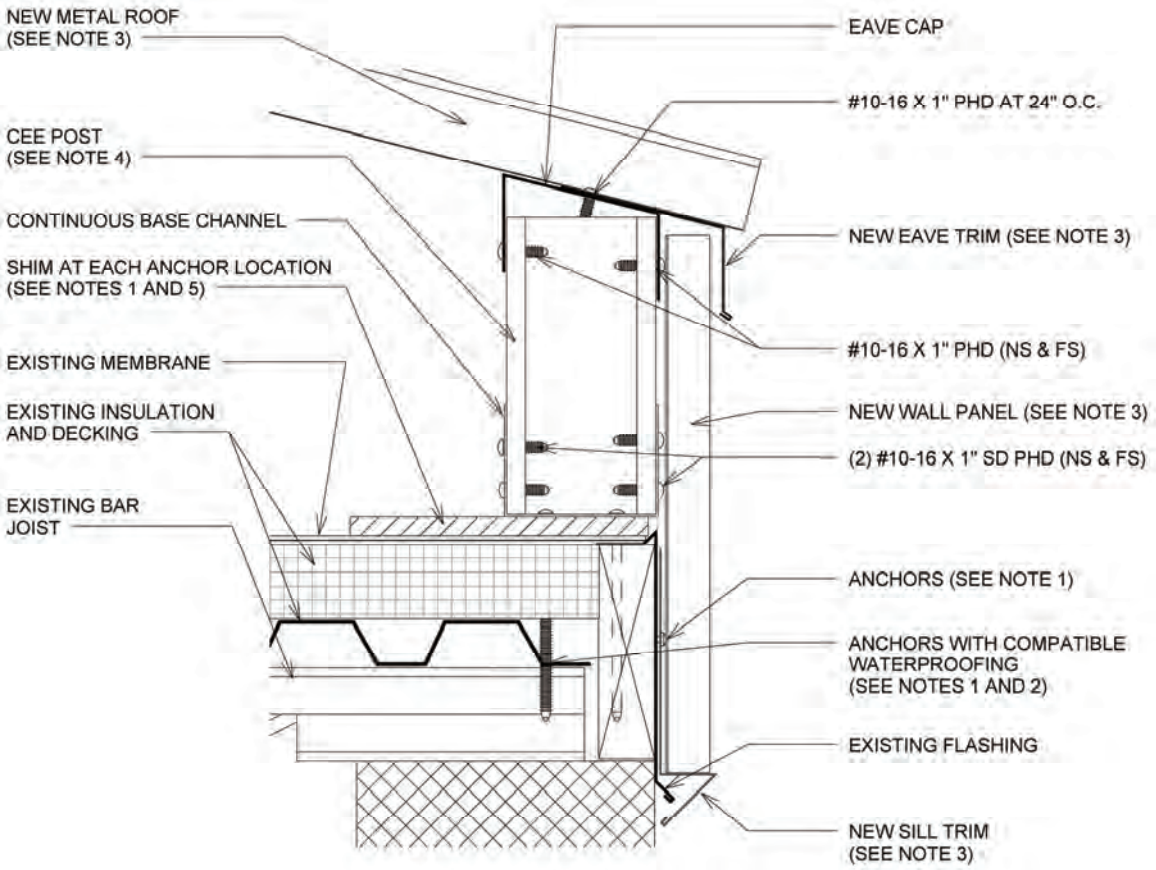


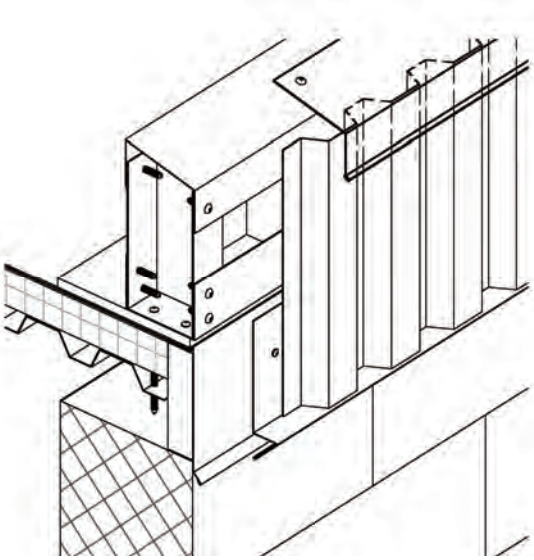
DETAIL A

NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT

metal sales manufacturing corporation	Date 5/15/2013	Low Two Piece Eave - Vented

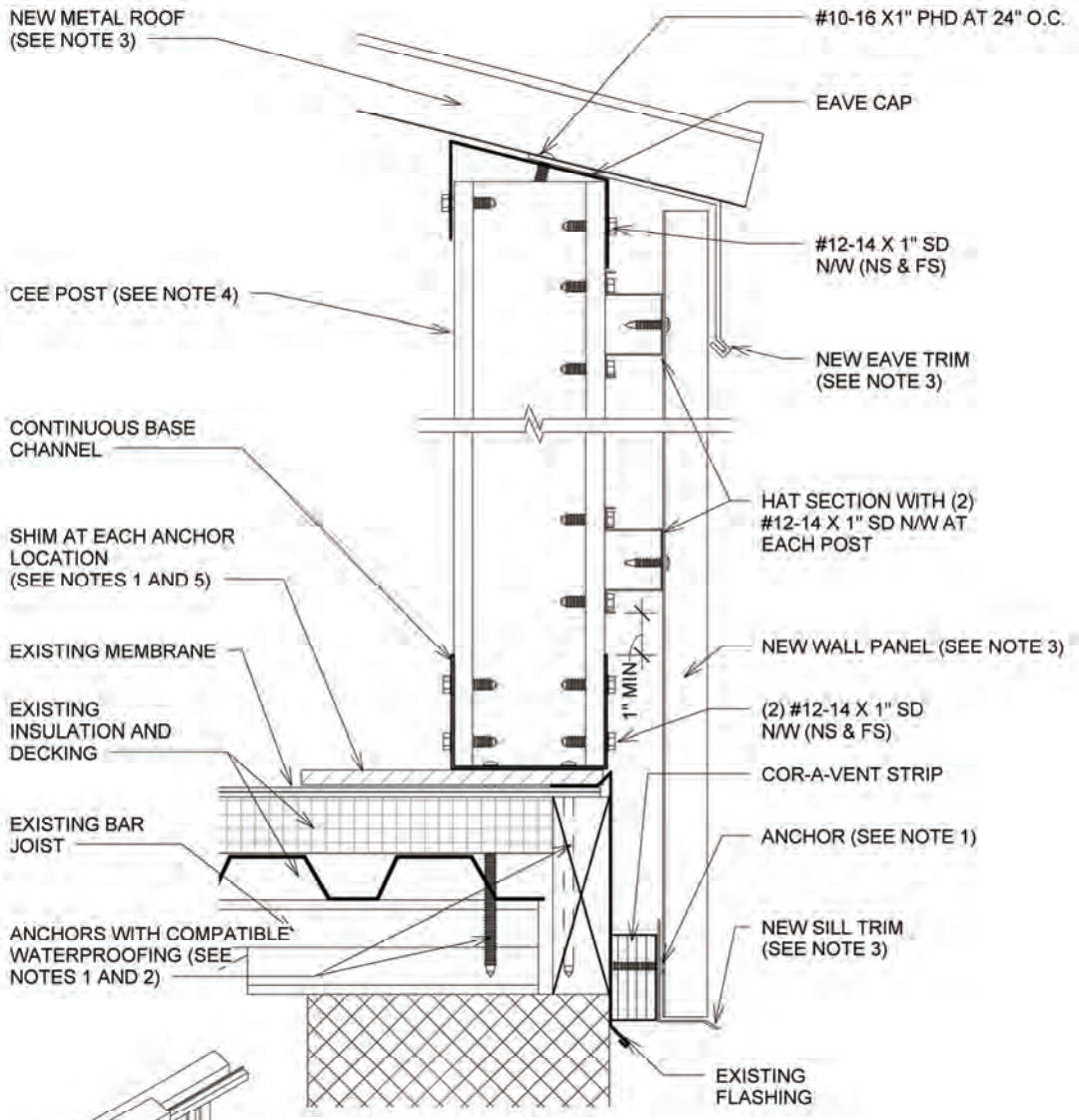


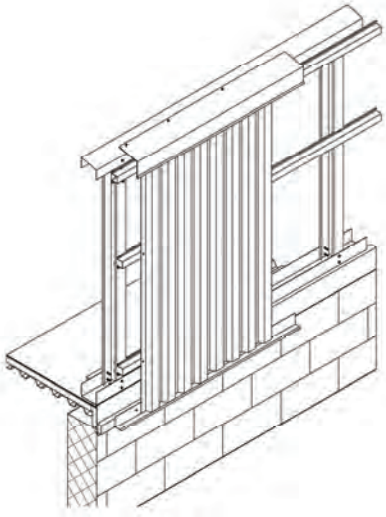


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Eave Post - Elevated Low Eave

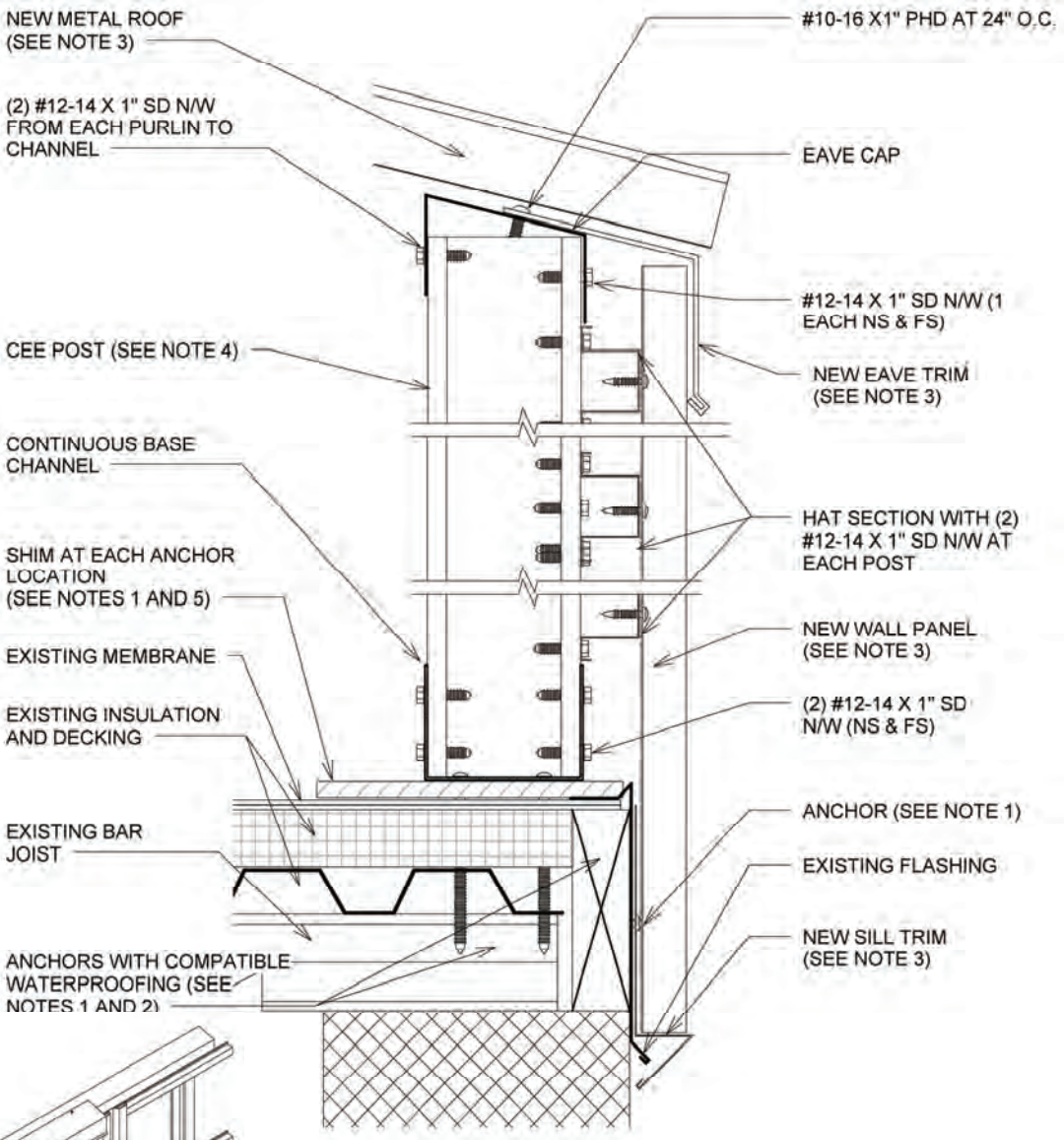


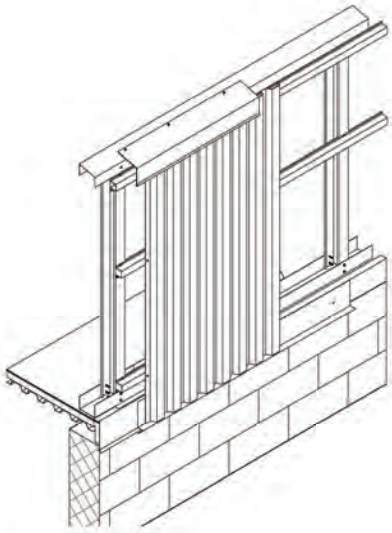


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Eave Post – Vented Elevated Low Eave with Hat Girts

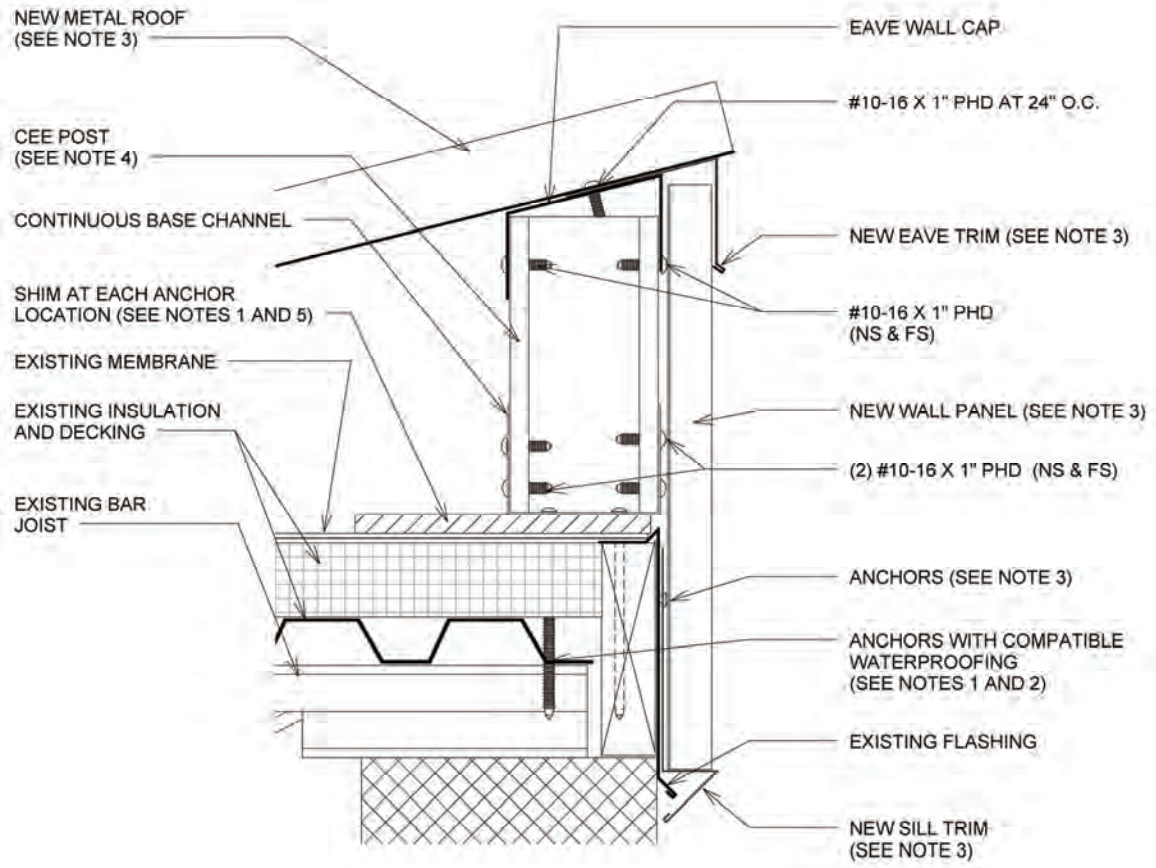


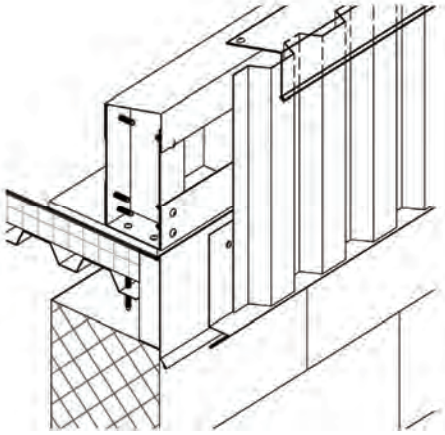


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Eave Post - Elevated Eave with Hat Girts

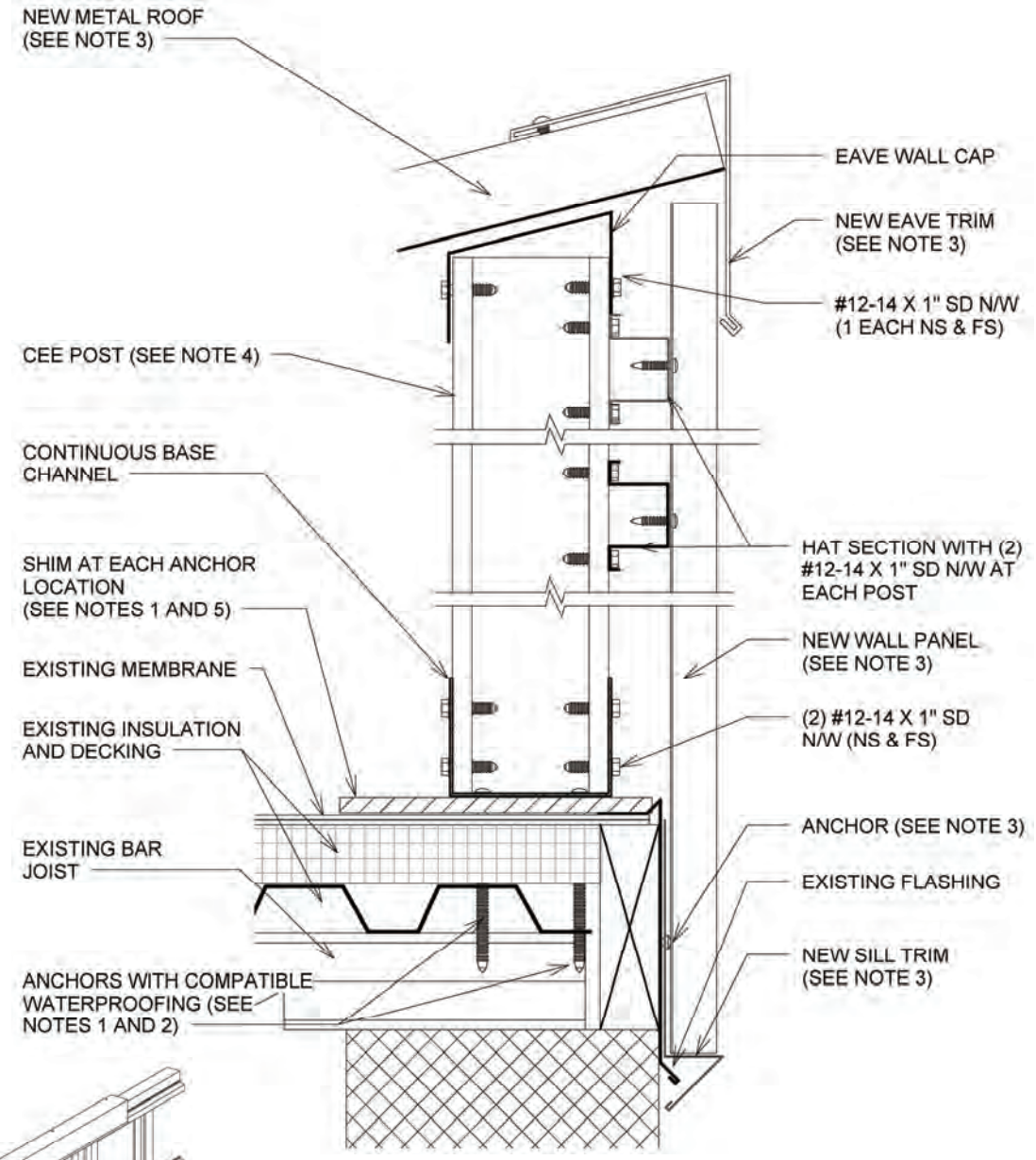


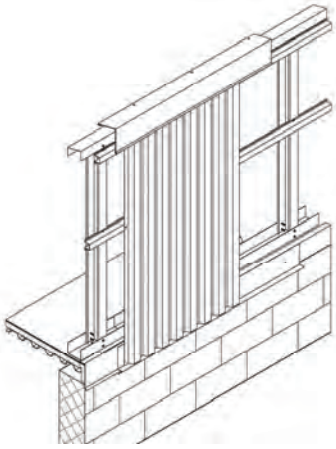


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Eave Post – Elevated High Eave

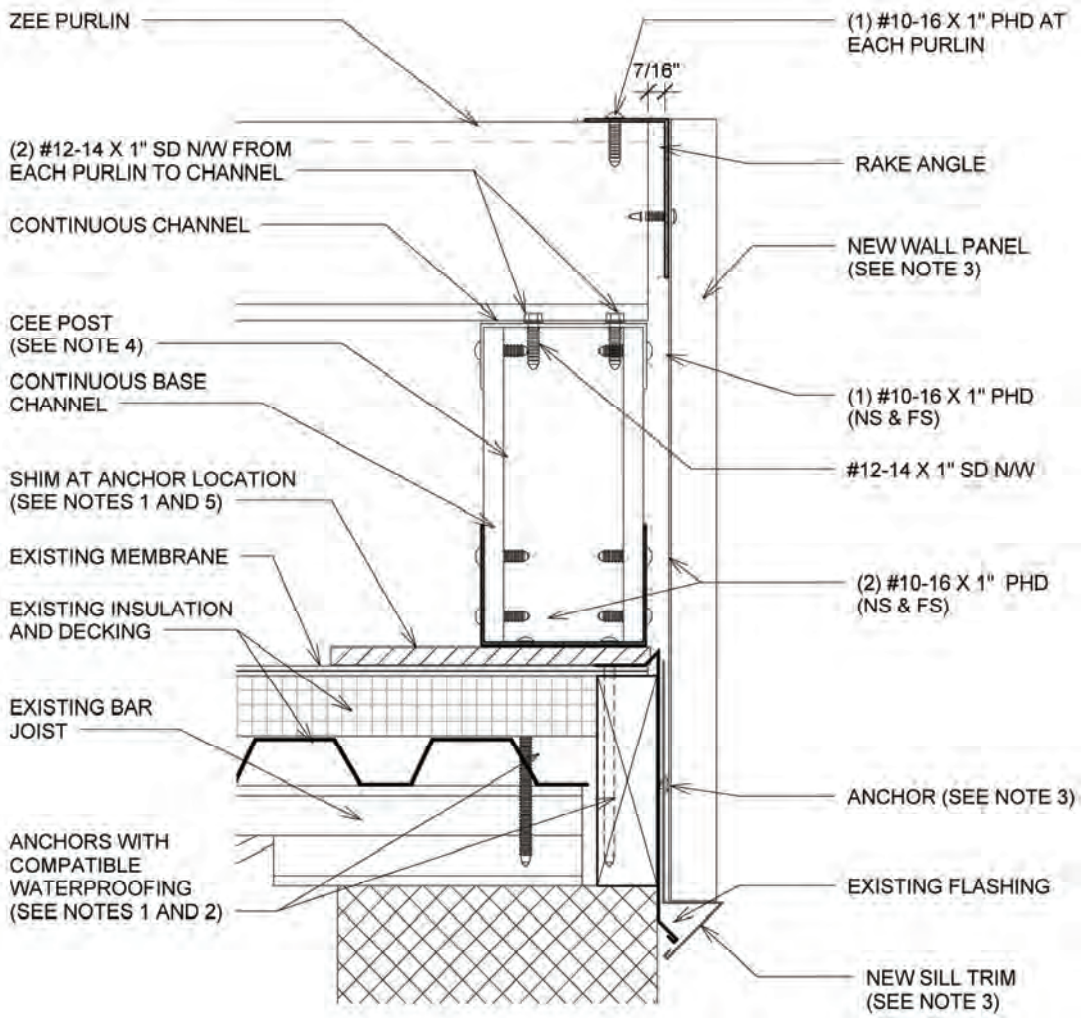


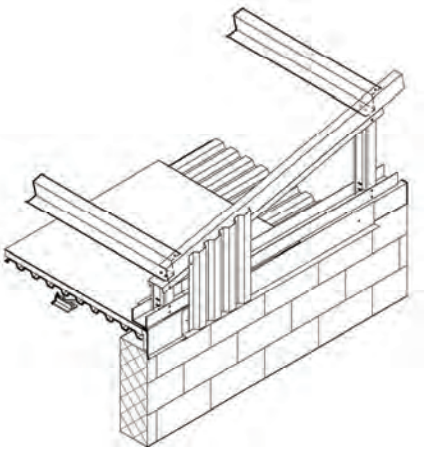


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Eave Post – Elevated High Eave with Hat Girt

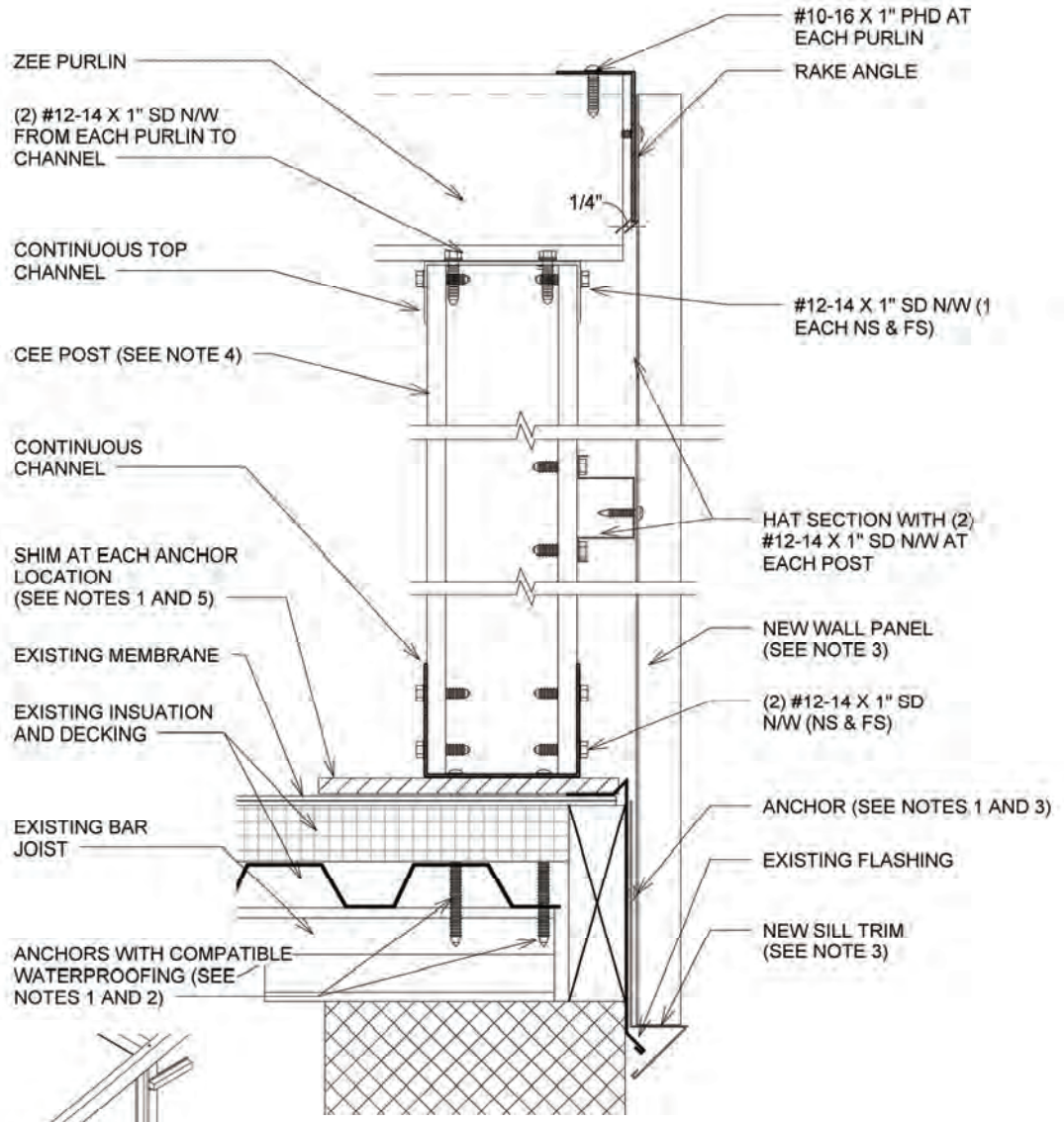


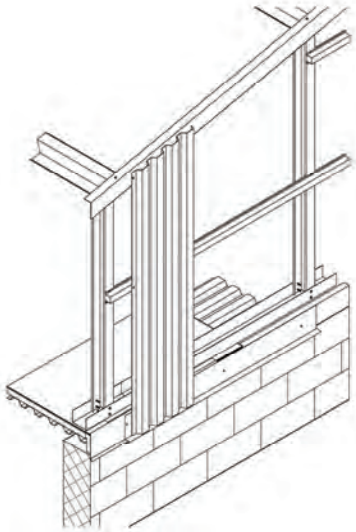


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Gable Post

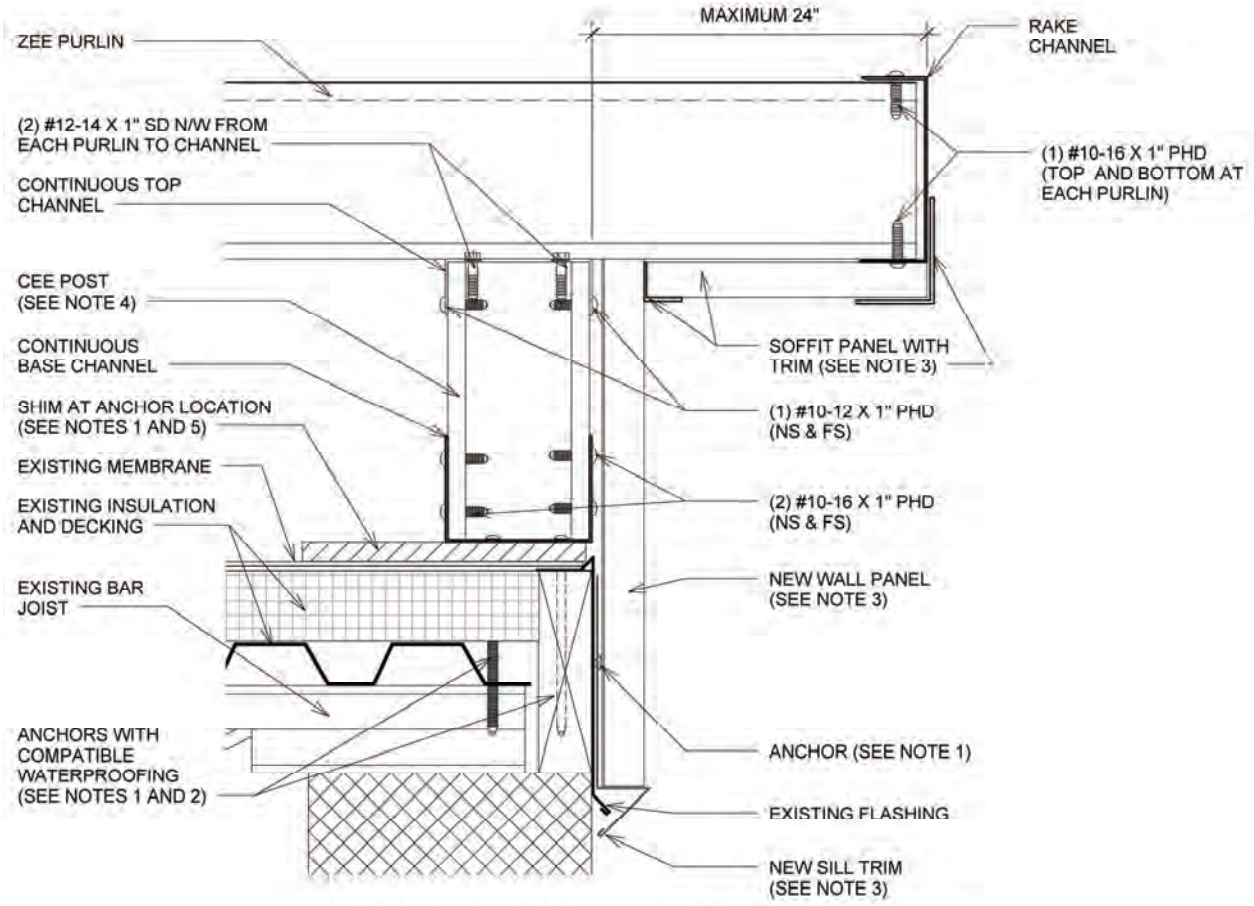


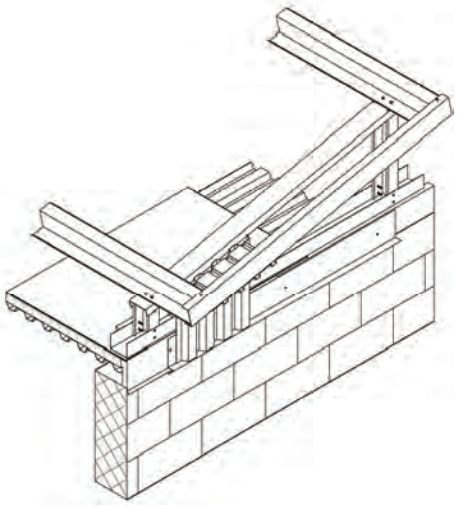


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Gable Post with Hat Girts

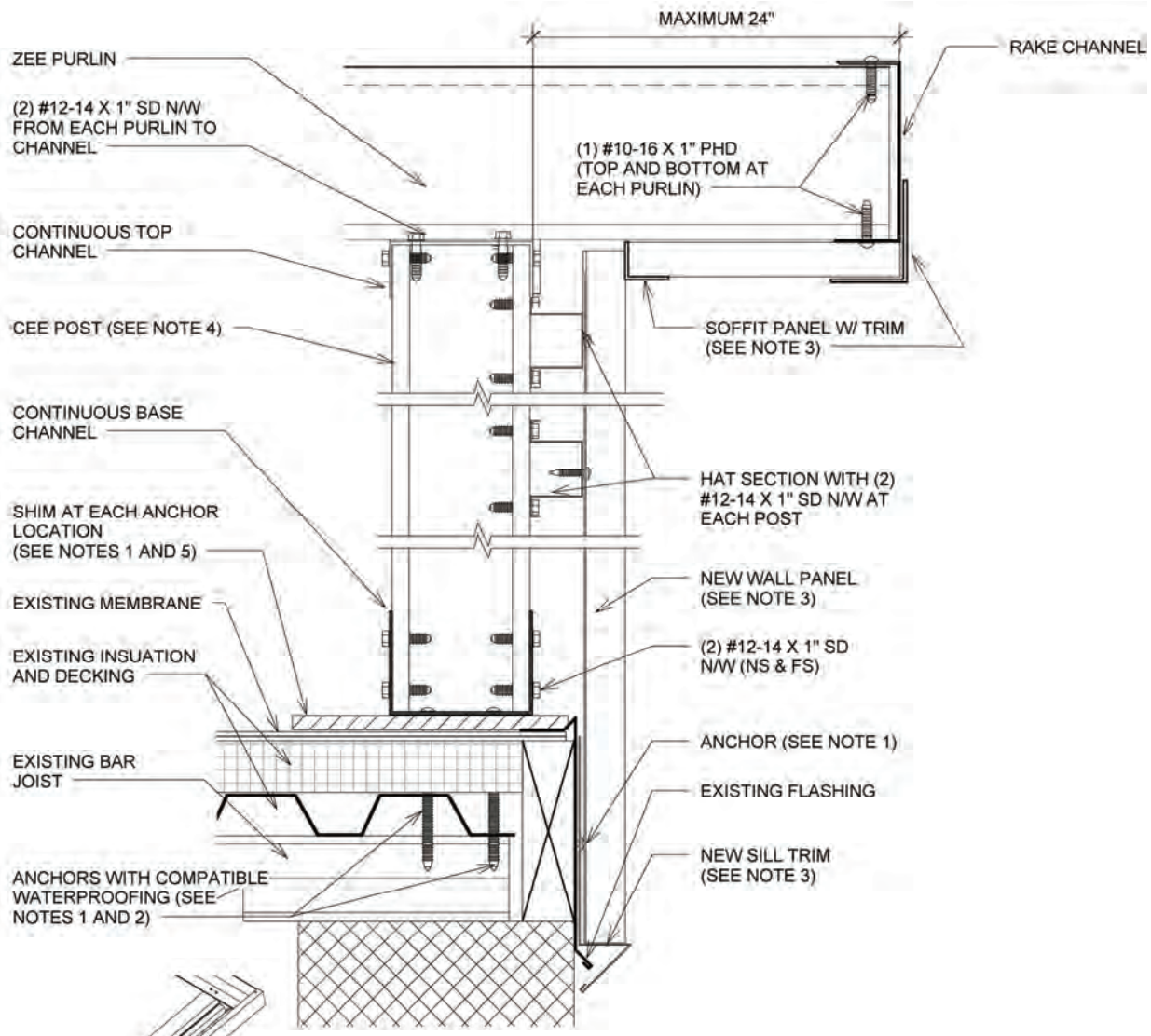


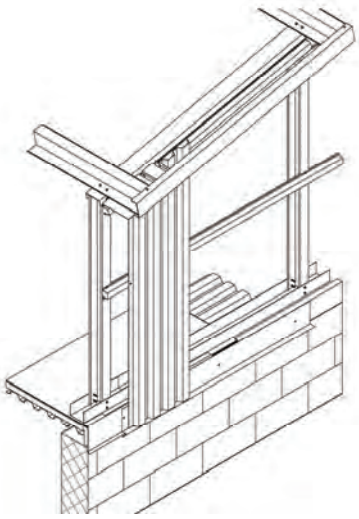


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Gable Post – Purlin Extension

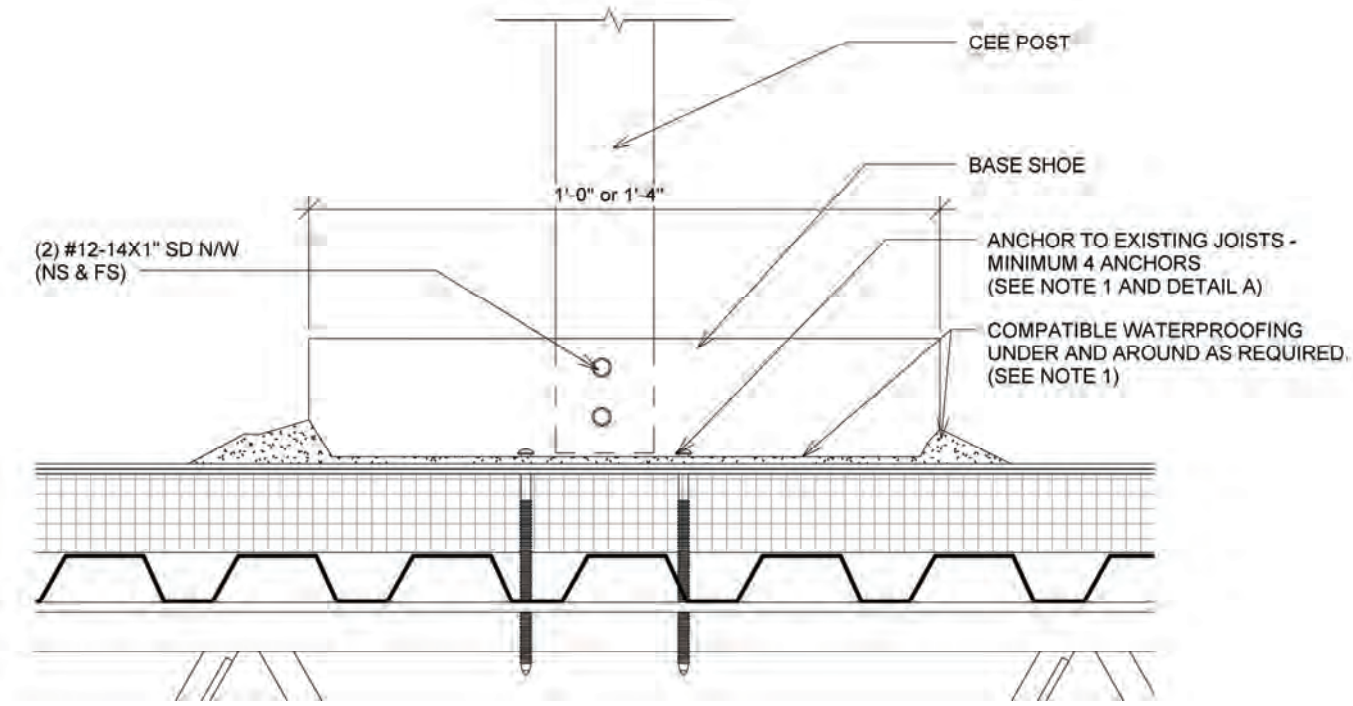


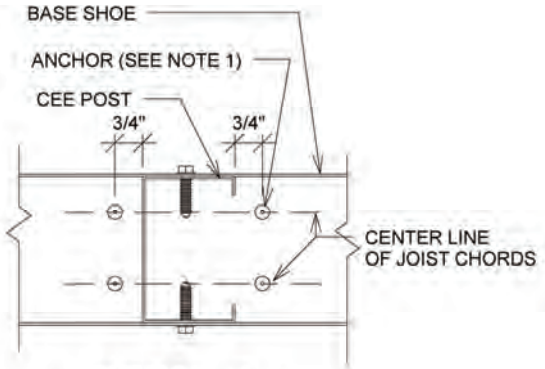


NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. SPACING VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Gable Post with Hat Girts/Purlin Extension



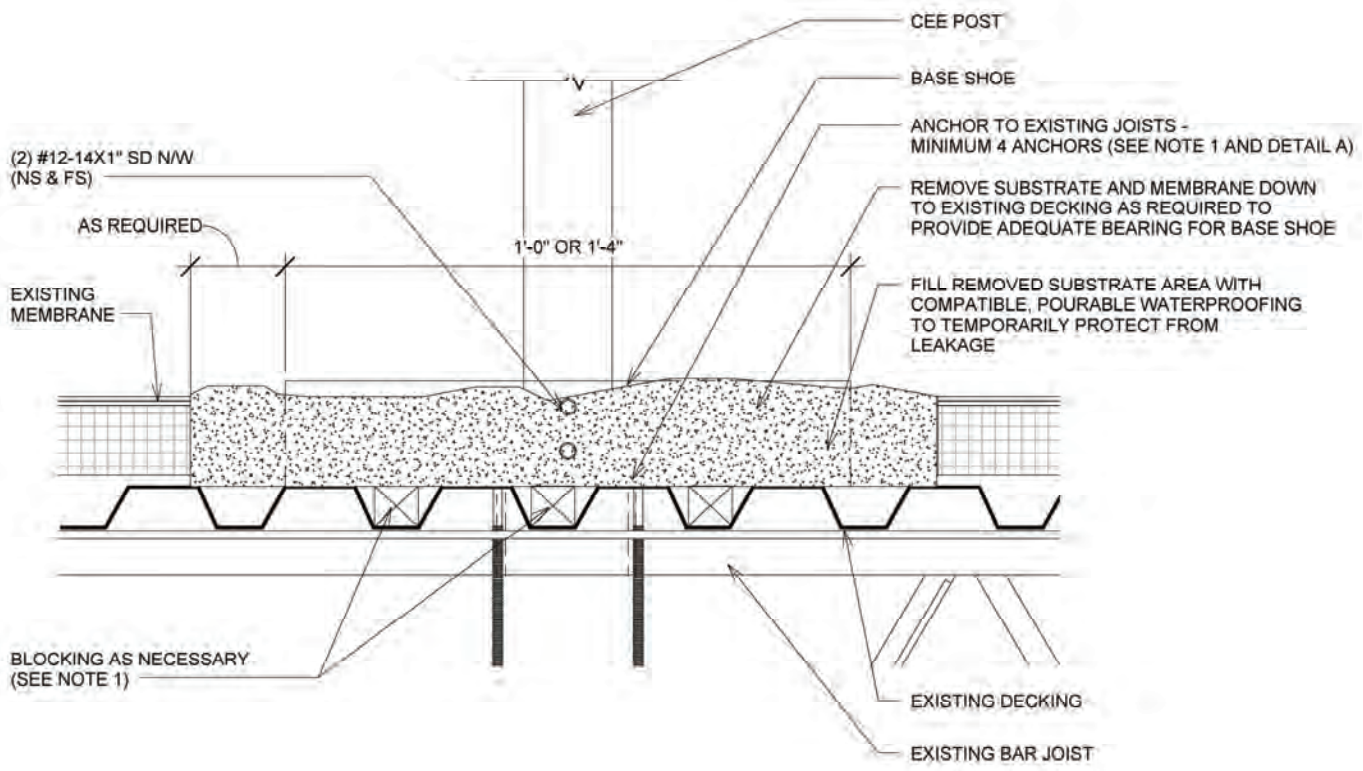


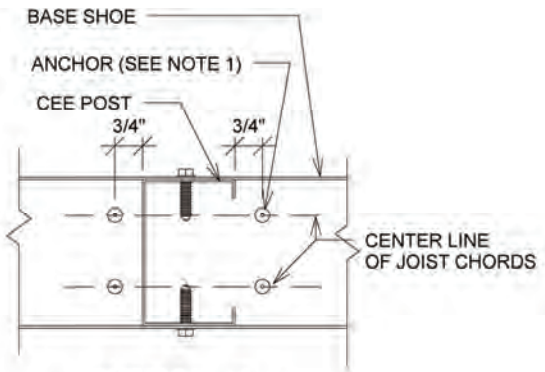
DETAIL A

NOTES:

1. NOT FURNISHED BY METAL SALES

metal sales manufacturing corporation	Date 5/15/2013	Base Shoe – Adequate Substrate



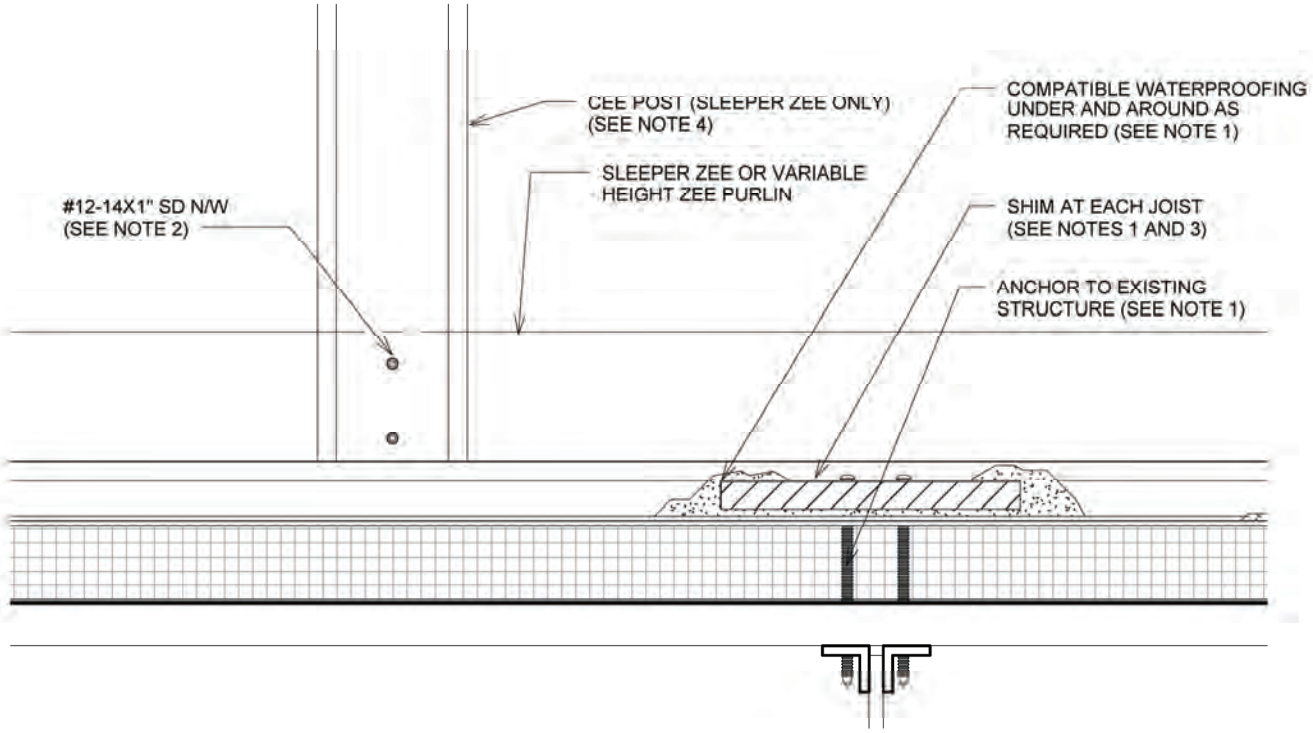


DETAIL A

NOTES:

1. NOT FURNISHED BY METAL SALES

metal sales manufacturing corporation	Date 5/15/2013	Base Shoe – Inadequate Substrate

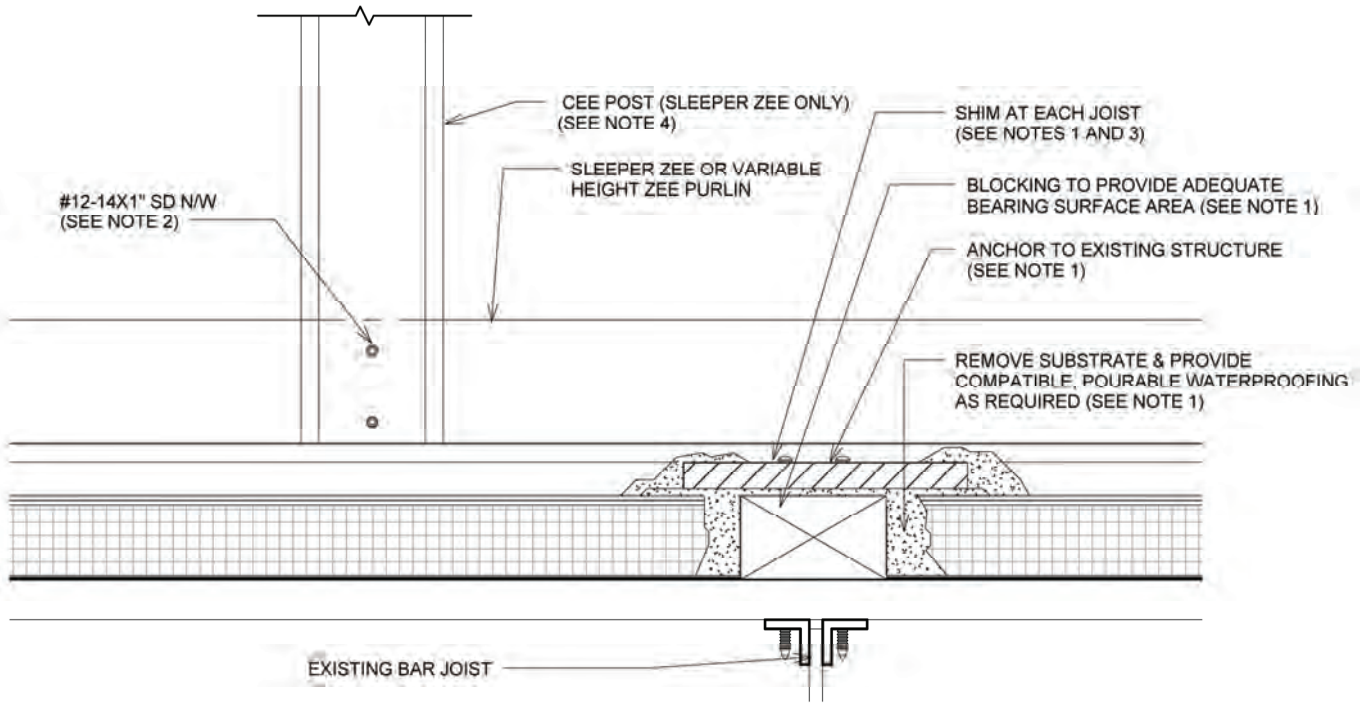


NOTE: DETAIL IS SIMILAR FOR VARIABLE HEIGHT ZEE

NOTES:

1. NOT FURNISHED BY METAL SALES
2. QUANTITY OF FASTENERS VARY PER DESIGN
3. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
4. DOES NOT HAVE TO OCCUR OVER BAR JOIST

metal sales manufacturing corporation	Date 5/15/2013	Sleeper Zee – Adequate Substrate

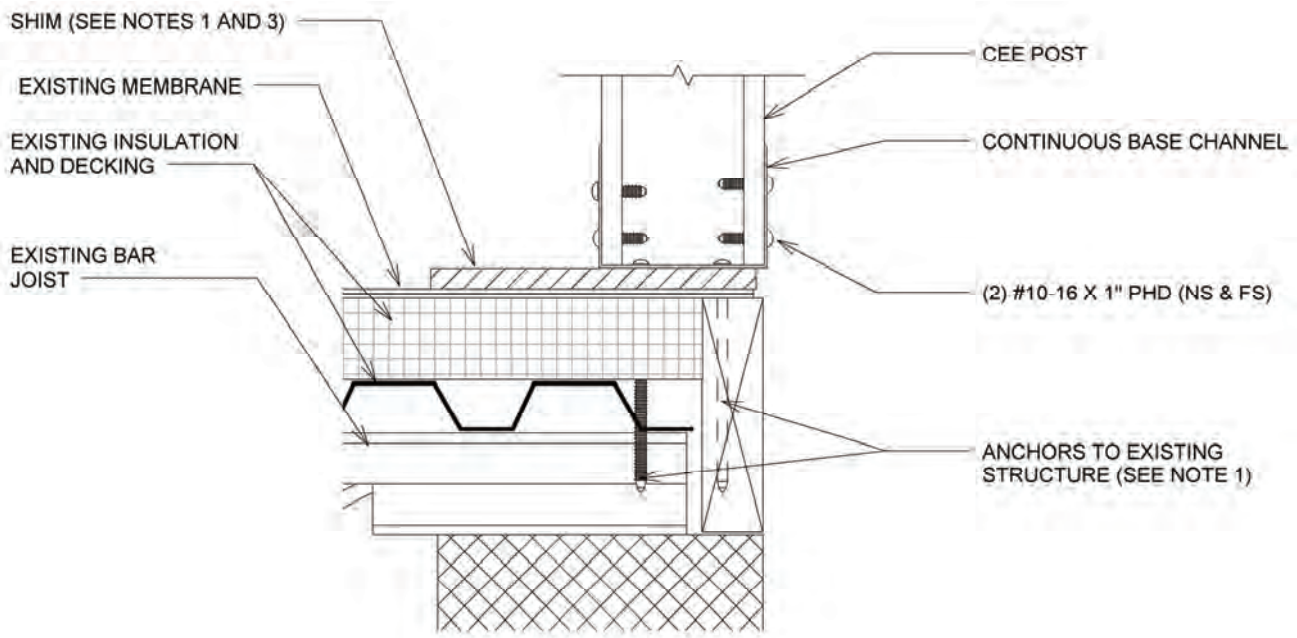


NOTE: DETAIL IS SIMILAR FOR VARIABLE HEIGHT ZEE

NOTES:

1. NOT FURNISHED BY METAL SALES
2. QUANTITY OF FASTENERS VARY PER DESIGN
3. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
4. DOES NOT HAVE TO OCCUR OVER BAR JOIST

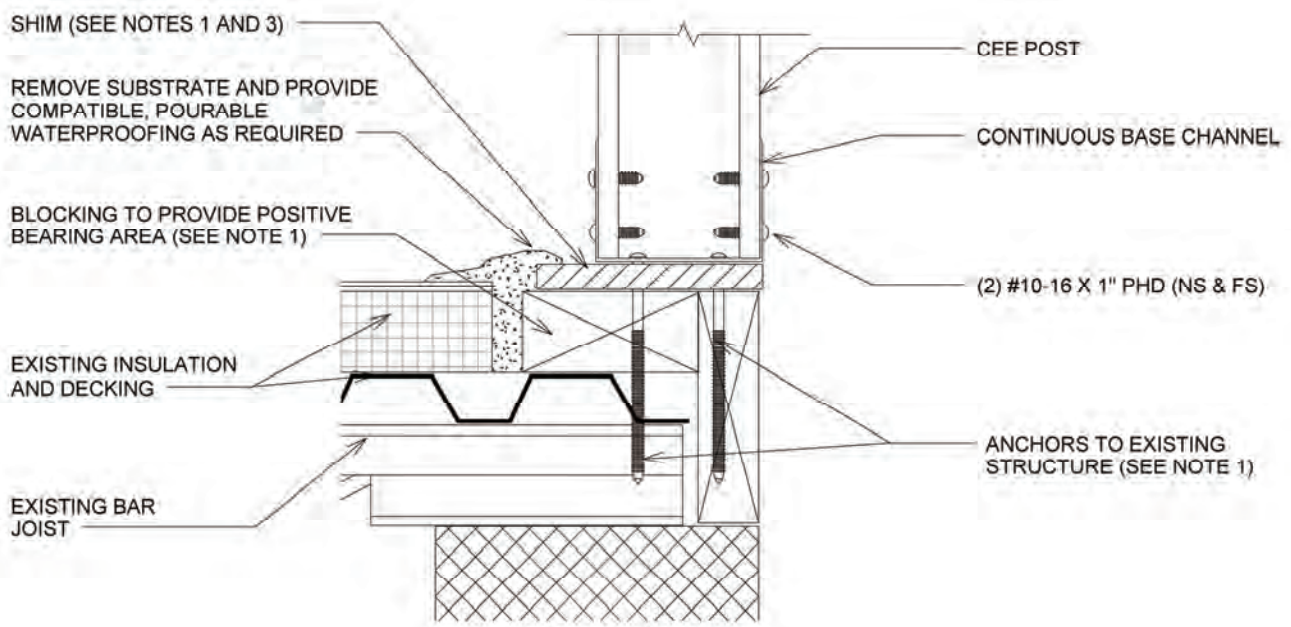
metal sales manufacturing corporation	Date 5/15/2013	Sleeper Zee – Inadequate Substrate



NOTES:

1. NOT FURNISHED BY METAL SALES
2. QUANTITY OF FASTENERS VARY PER DESIGN
3. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

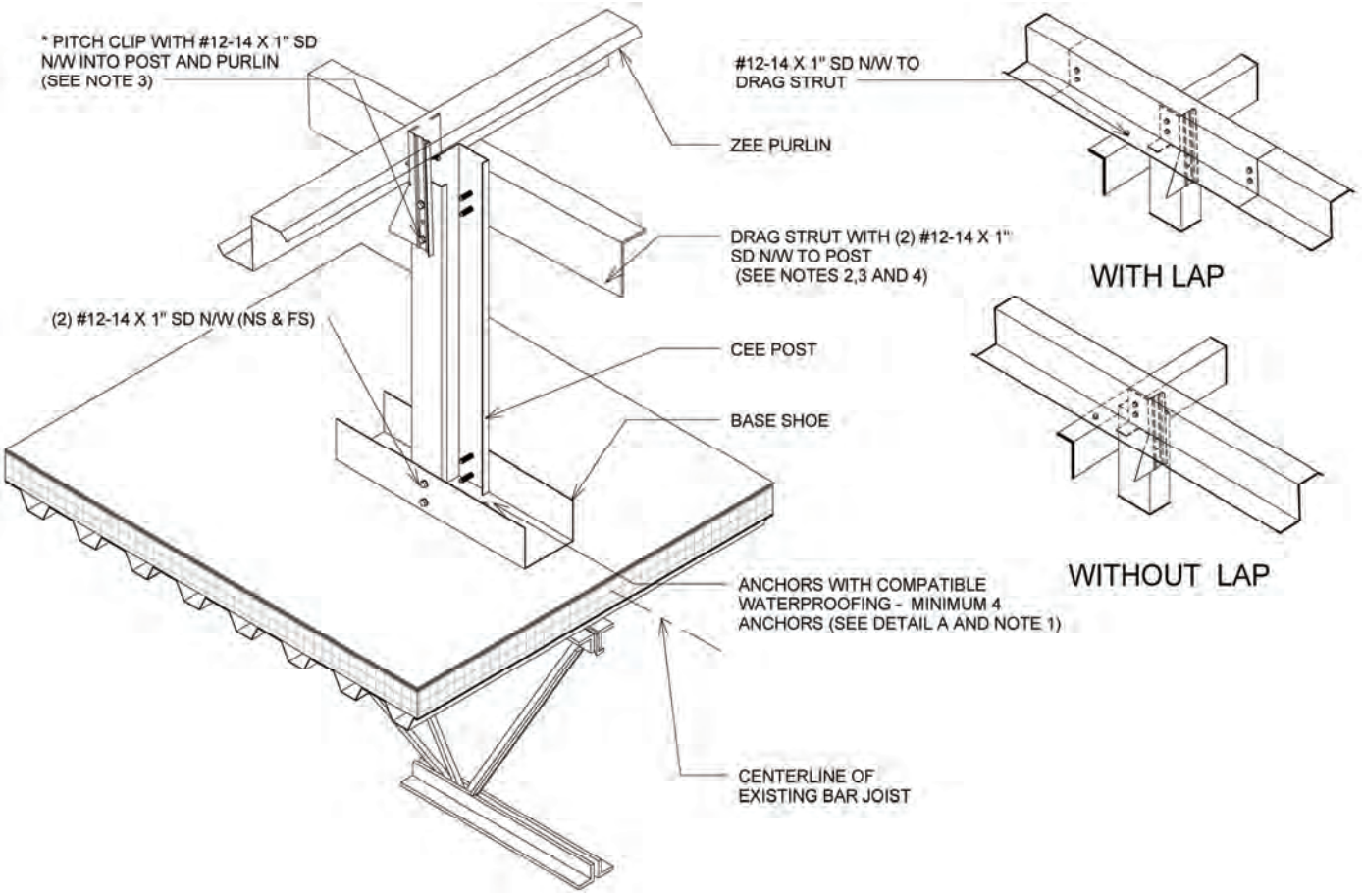
metal sales manufacturing corporation	Date 5/15/2013	Base Channel - Adequate Substrate



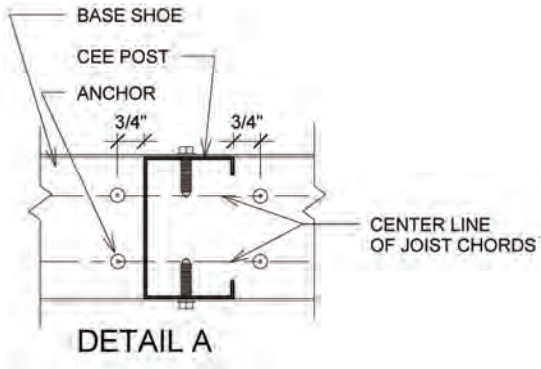
NOTES:

1. NOT FURNISHED BY METAL SALES
2. QUANTITY OF FASTENERS VARY PER DESIGN
3. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Base Channel - Inadequate Substrate



* PITCH CLIP IS PATENT PENDING

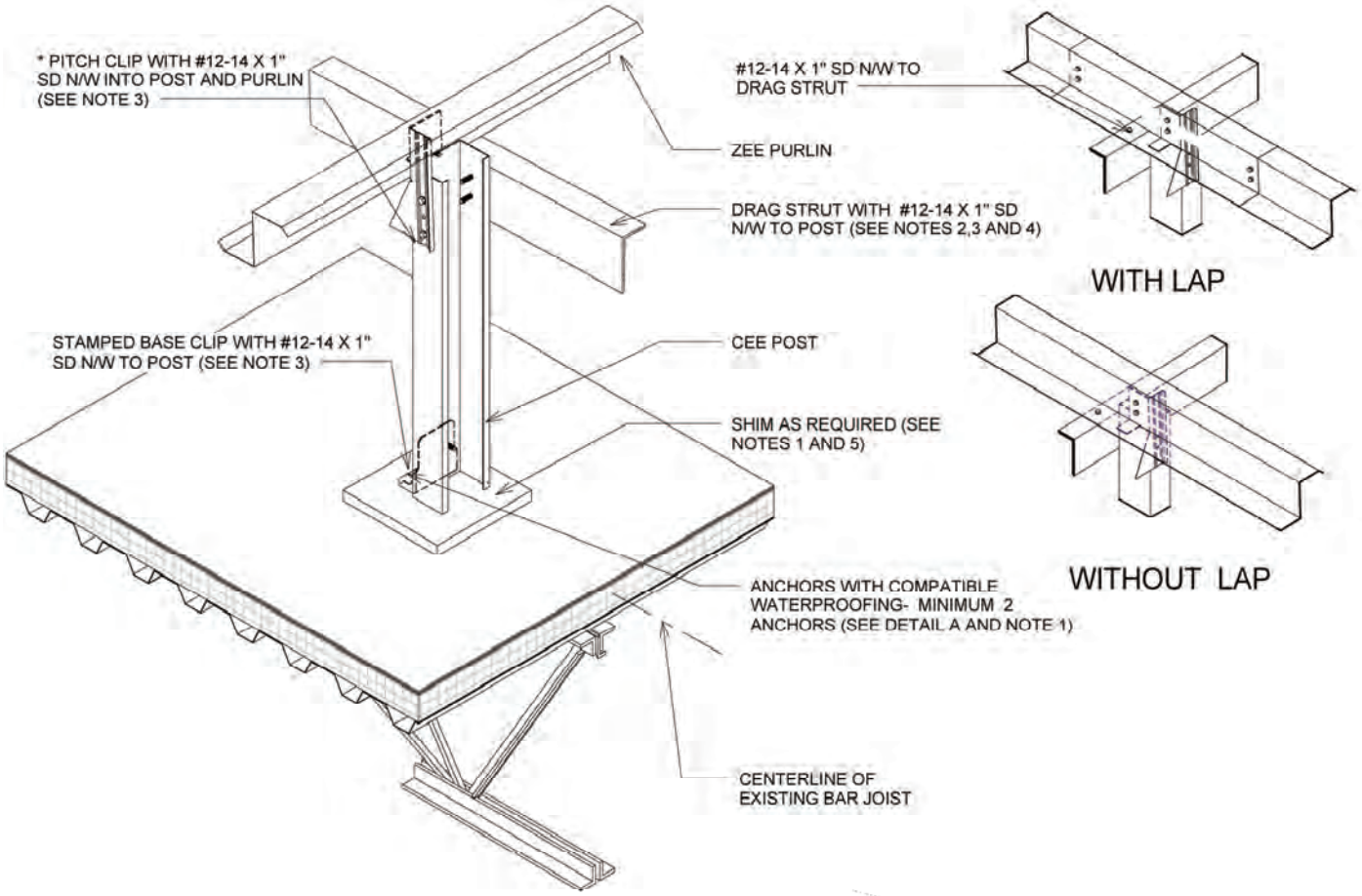


DETAIL A

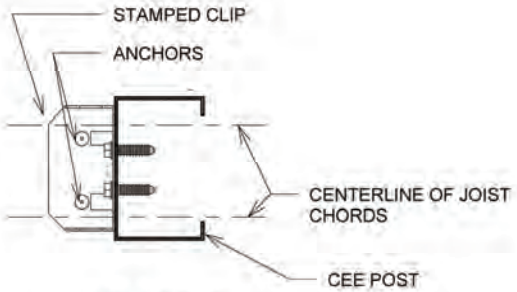
NOTES:

1. NOT FURNISHED BY METAL SALES
2. SPACING VARIES PER DESIGN
3. QUANTITYOF FASTENERS VARY PER DESIGN
4. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Pitch Clip/Base Shoe-Parallel



* PITCH CLIP IS PATENT PENDING

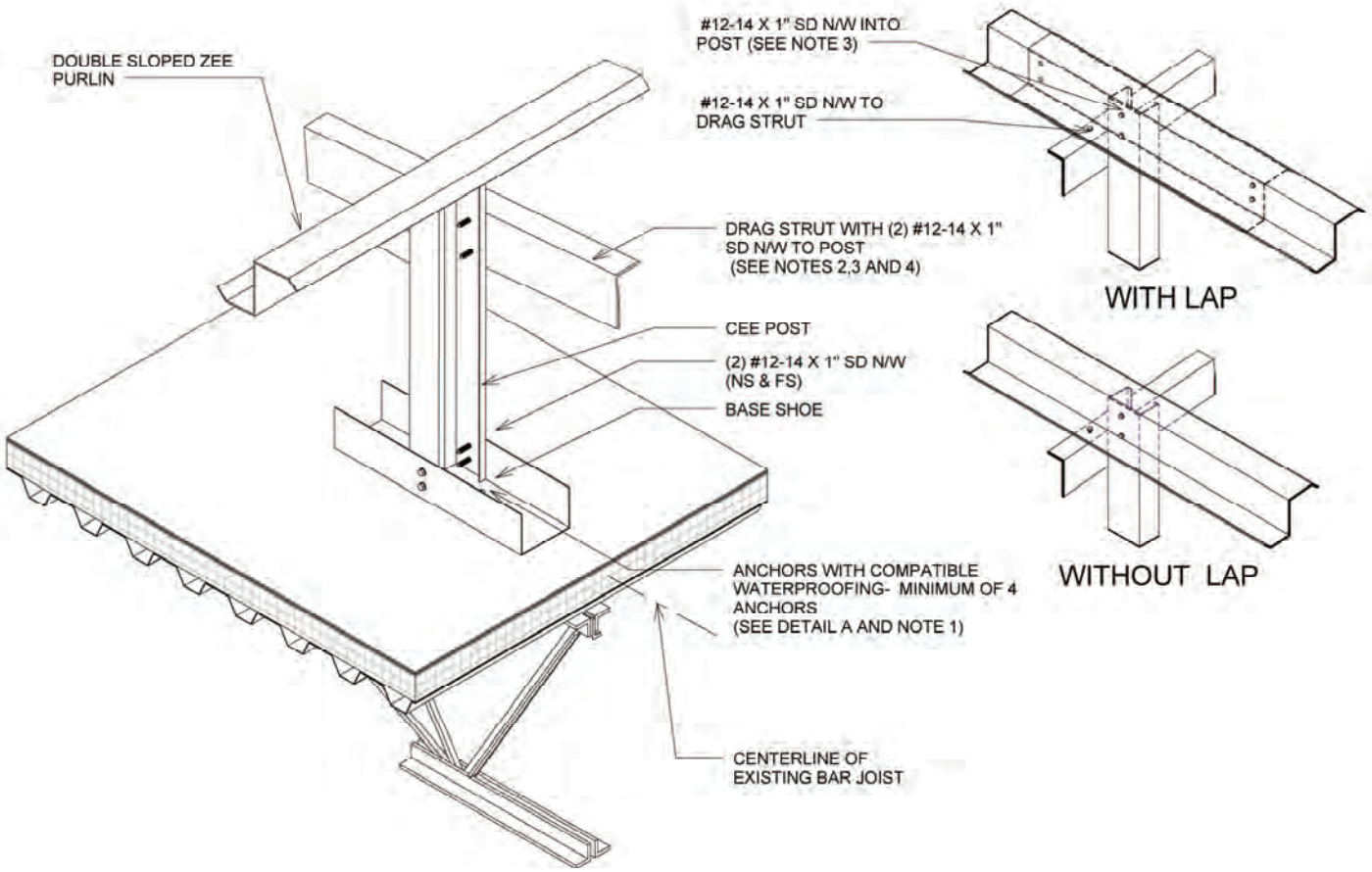


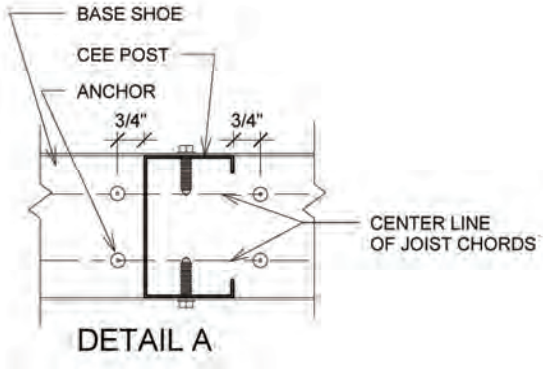
DETAIL A

NOTES:

1. NOT FURNISHED BY METAL SALES
2. SPACING VARIES PER DESIGN
3. QUANTITY OF FASTENERS VARY PER DESIGN
4. SIZE VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Pitch Clip/Base Clip - Parallel

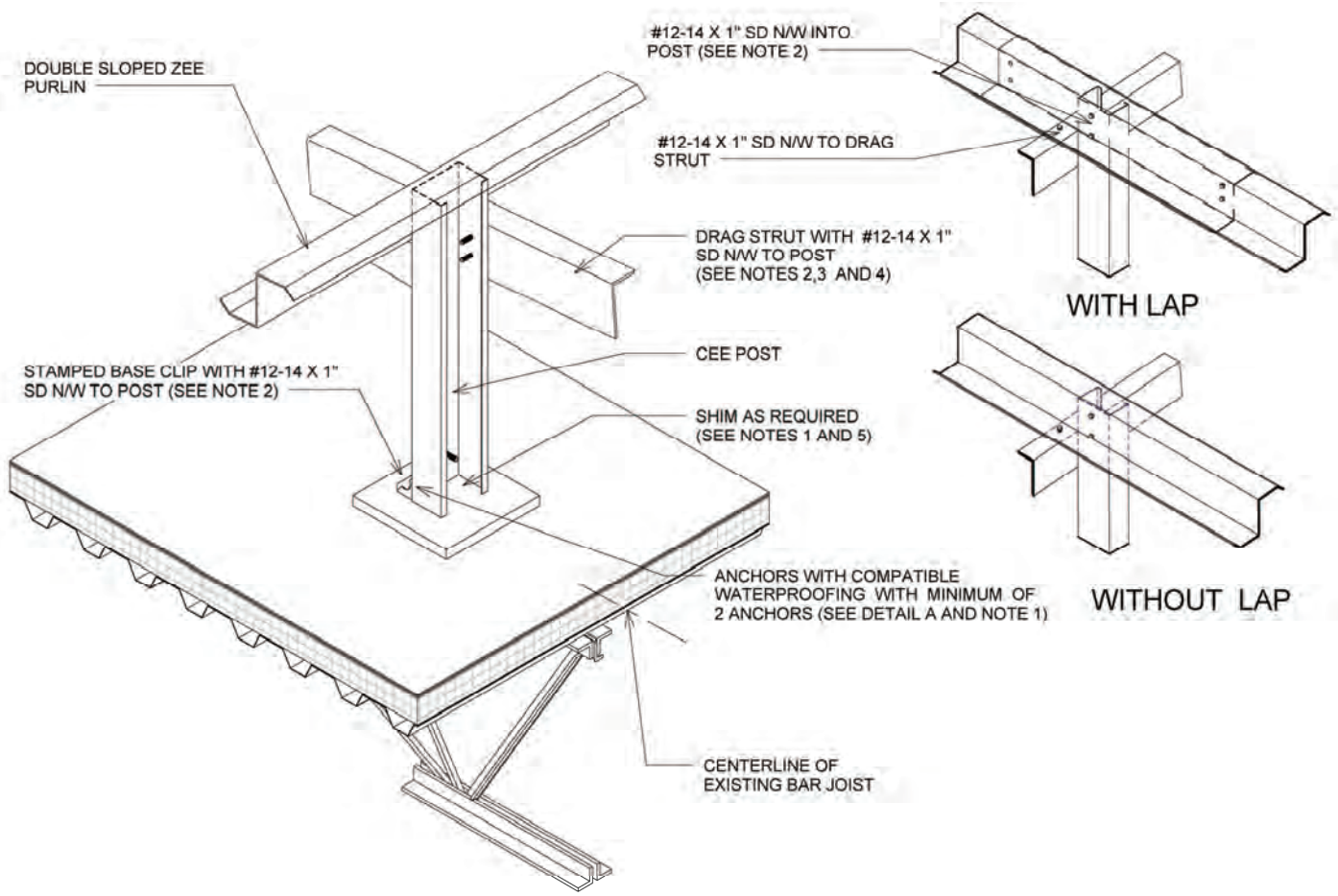


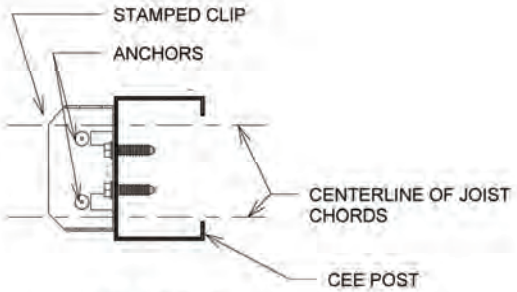


NOTES:

1. NOT FURNISHED BY METAL SALES
2. SPACING VARIES PER DESIGN
3. QUANTITYOF FASTENERS VARY PER DESIGN
4. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Double Sloped Purlin/ Base Shoe - Parallel



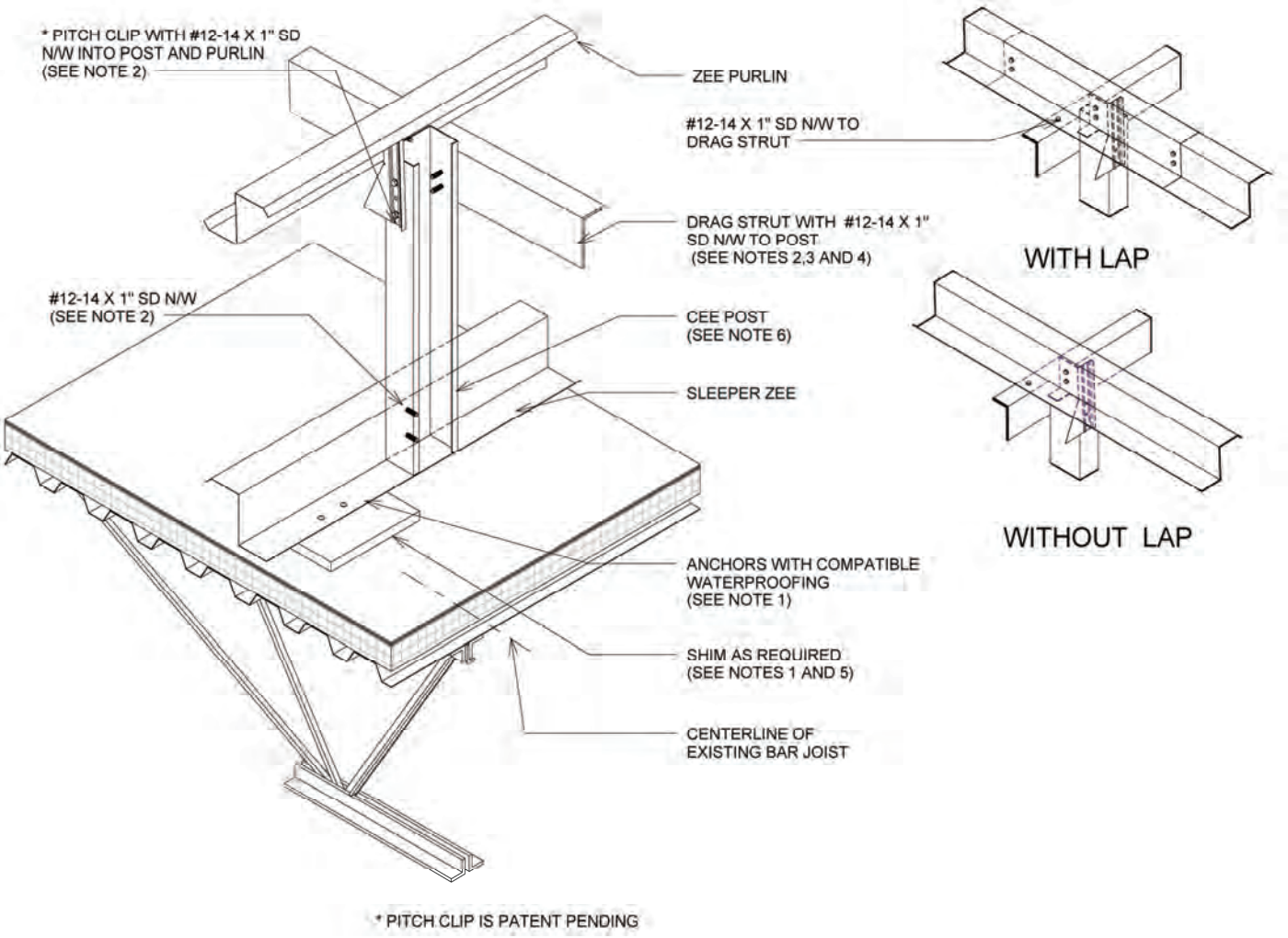


DETAIL A

NOTES:

1. NOT FURNISHED BY METAL SALES
2. SPACING VARIES PER DESIGN
3. QUANTITY OF FASTENERS VARY PER DESIGN
4. SIZE VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

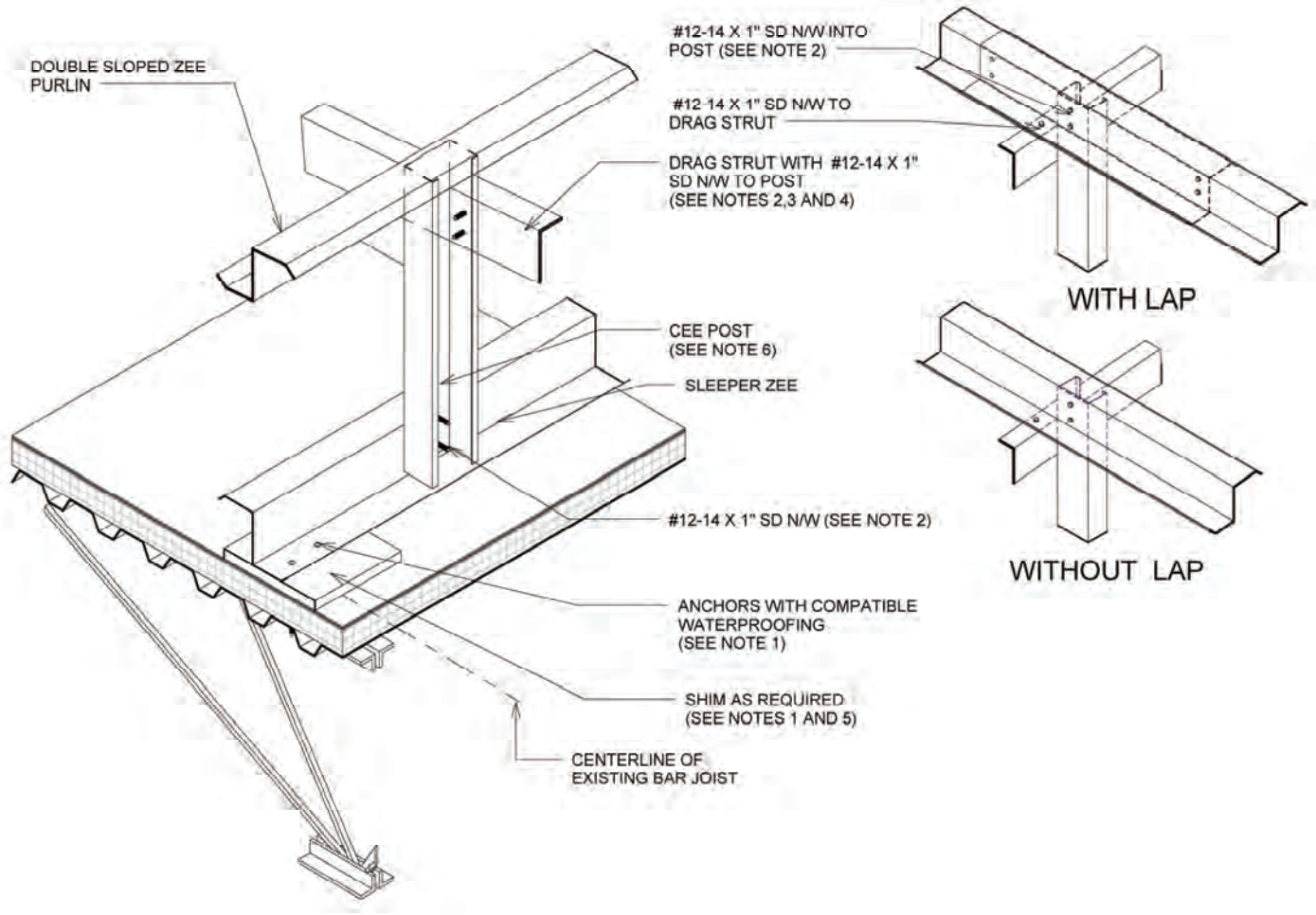
metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Double Sloped Purlin/ Base Clip - Parallel



NOTES:

1. NOT FURNISHED BY METAL SALES
2. QUANTITY OF FASTENERS VARY PER DESIGN
3. SPACING VARIES PER DESIGN
4. SIZE VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
6. DOES NOT HAVE TO OCCUR OVER BAR JOIST

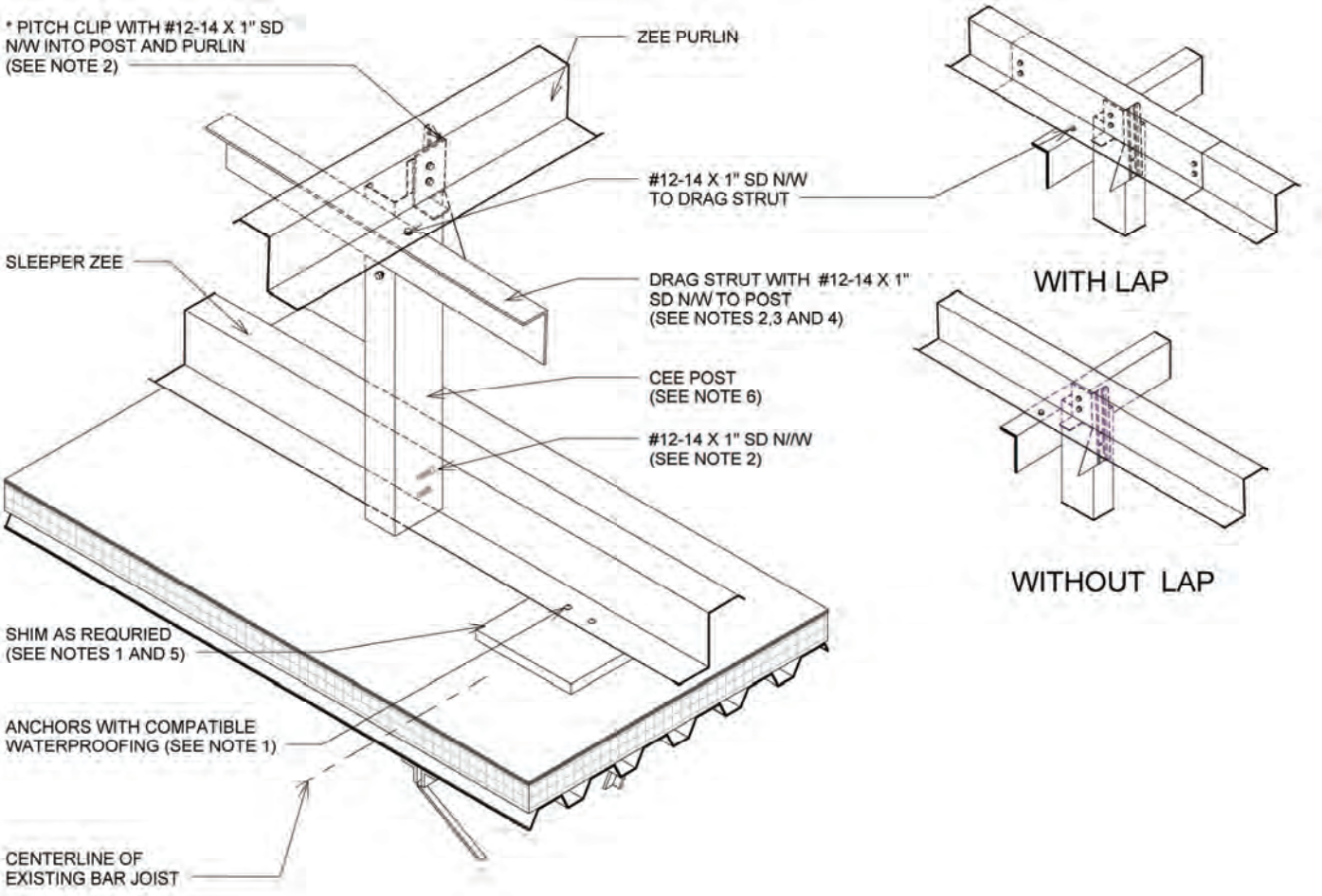
metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Pitch Clip/Sleeper Zee - Parallel



NOTES:

1. NOT FURNISHED BY METAL SALES
2. QUANTITY OF FASTENERS VARY PER DESIGN
3. SPACING VARIES PER DESIGN
4. SIZE VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
6. DOES NOT HAVE TO OCCUR OVER BAR JOIST

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Double Sloped Purlin/ Sleeper Zee - Parallel

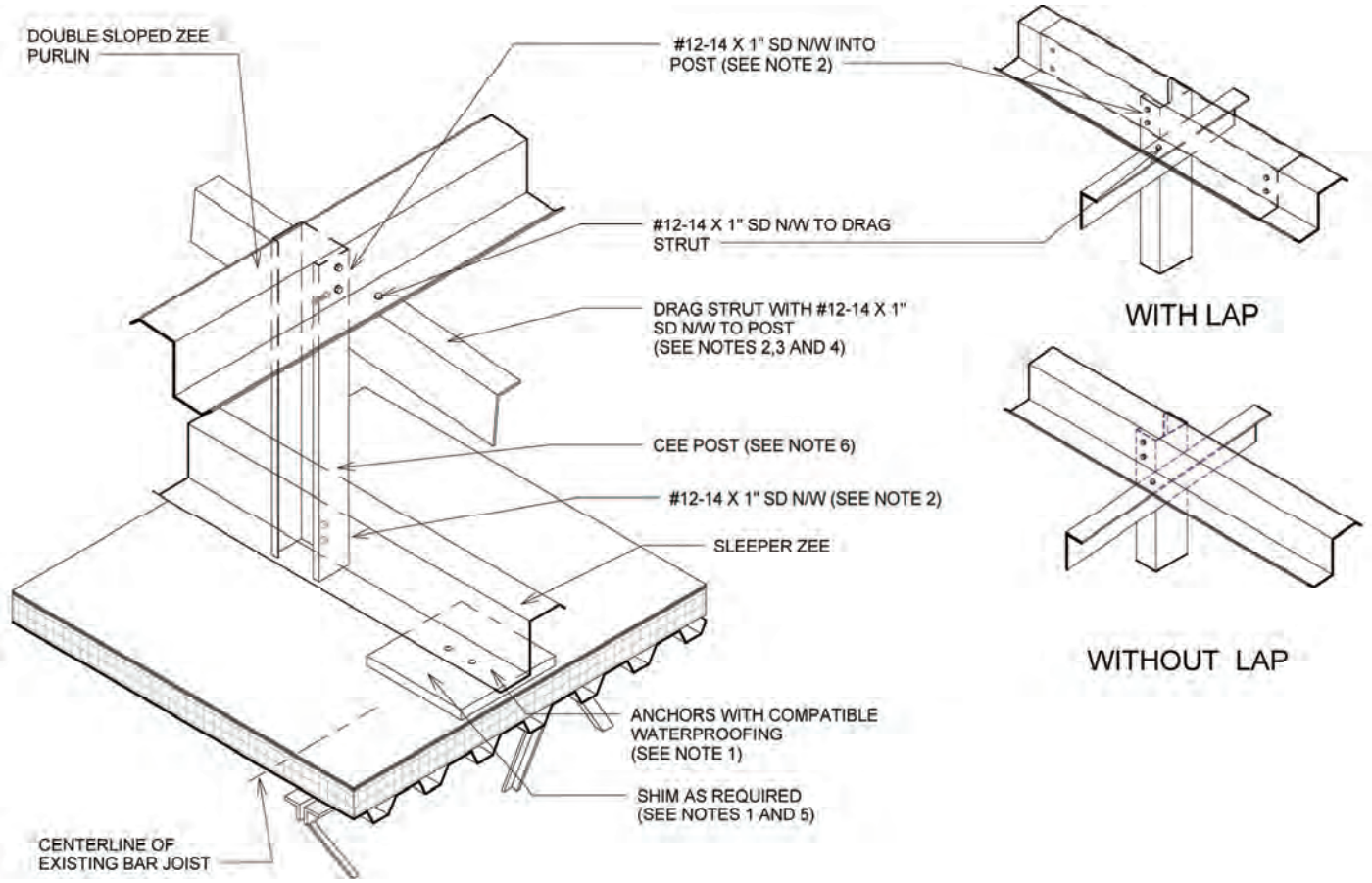


* PITCH CLIP IS PATENT PENDING

NOTES:

1. NOT FURNISHED BY METAL SALES
2. QUANTITY OF FASTENERS VARY PER DESIGN
3. SPACING VARIES PER DESIGN
4. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
5. SIZE VARIES PER DESIGN
6. DOES NOT HAVE TO OCCUR OVER BAR JOIST

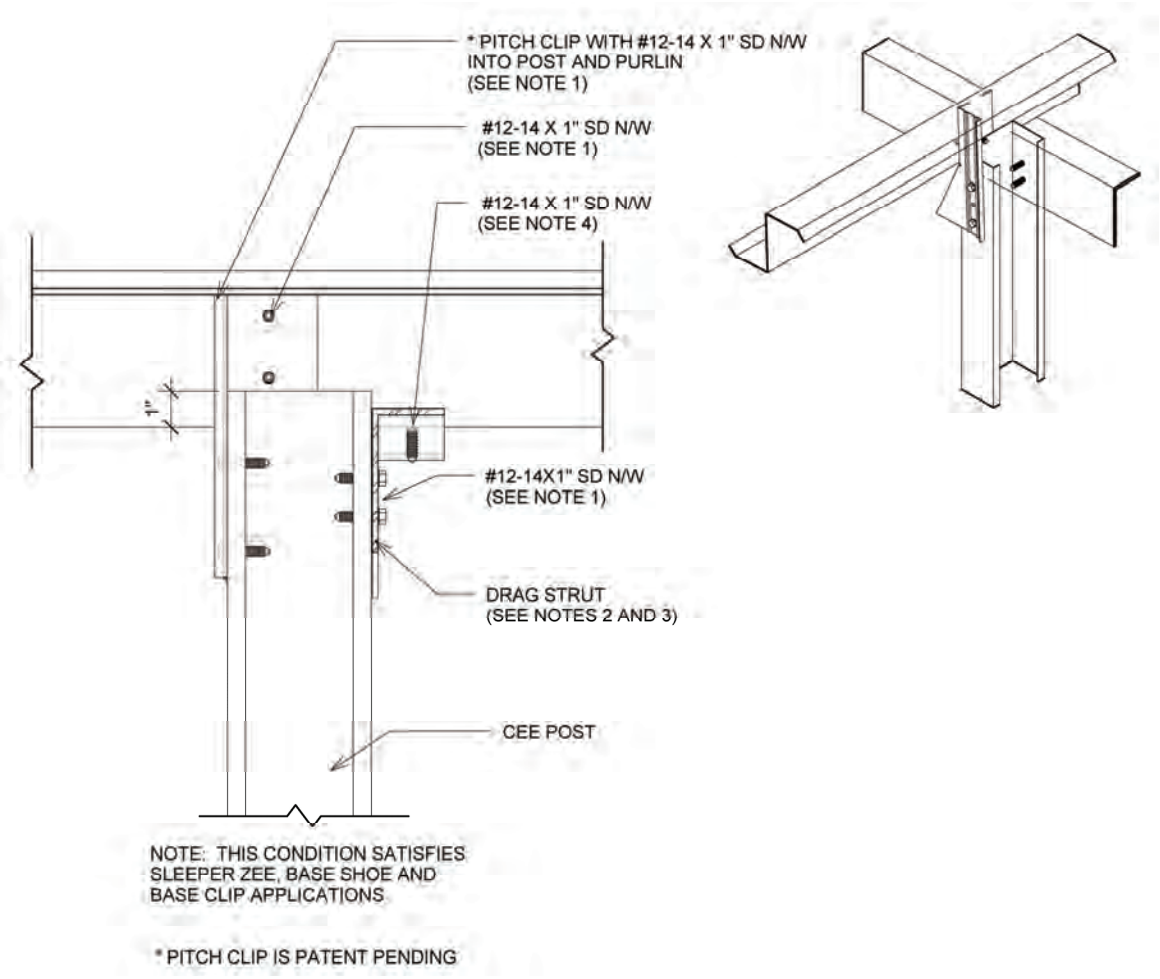
metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Pitch Clip/Sleeper Zee - Perpendicular



NOTES:

1. NOT FURNISHED BY METAL SALES
2. QUANTITY OF FASTENERS VARY PER DESIGN
3. SPACING VARIES PER DESIGN
4. SIZE VARIES PER DESIGN
5. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
6. DOES NOT HAVE TO OCCUR OVER BAR JOIST

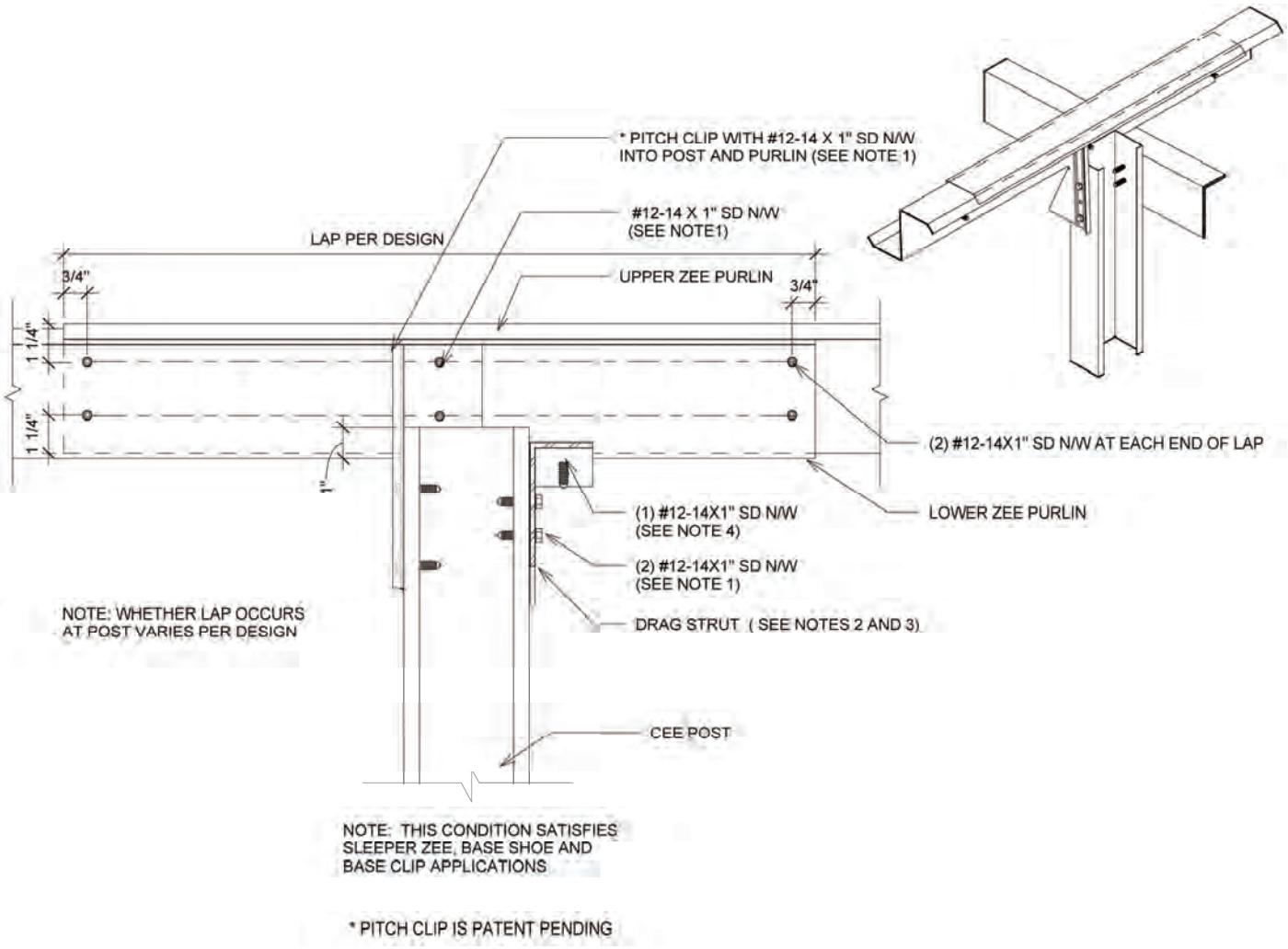
metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Double Sloped Purlin/ Sleeper Zee - Perpendicular



NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. DRAG SRUT TO PURLIN FLANGE

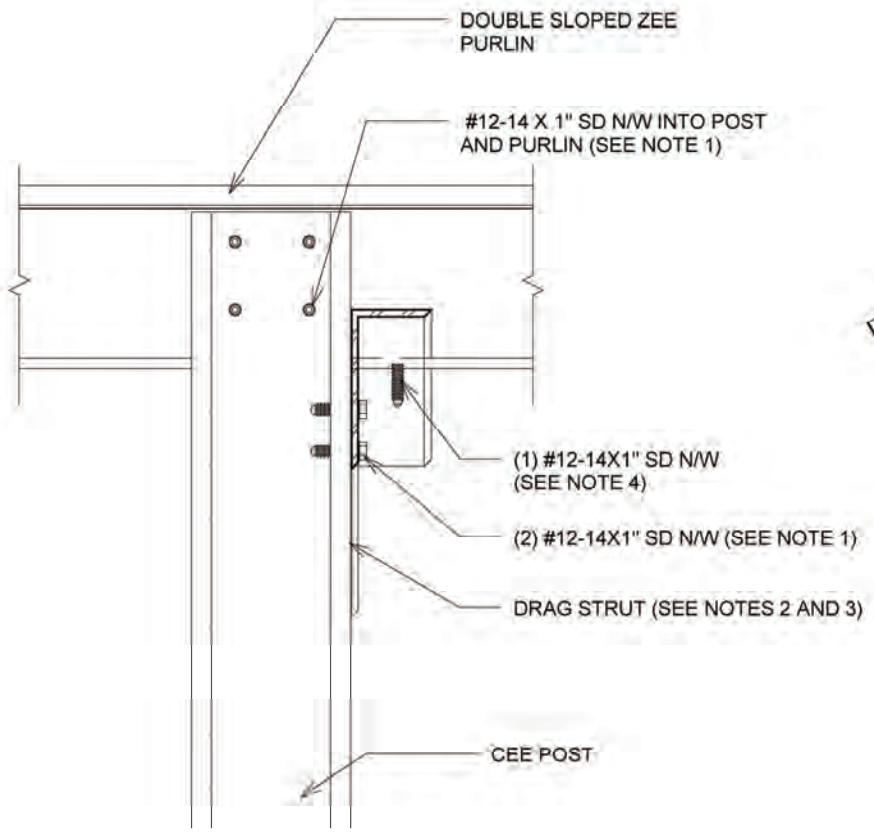
metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Pitch Clip/No Purlin Lap – All Bases

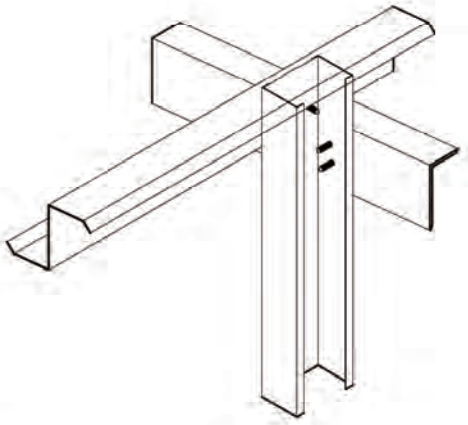


NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. DRAG SRUT TO PURLIN FLANGE

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Pitch Clip/Purlin Lap – All Bases



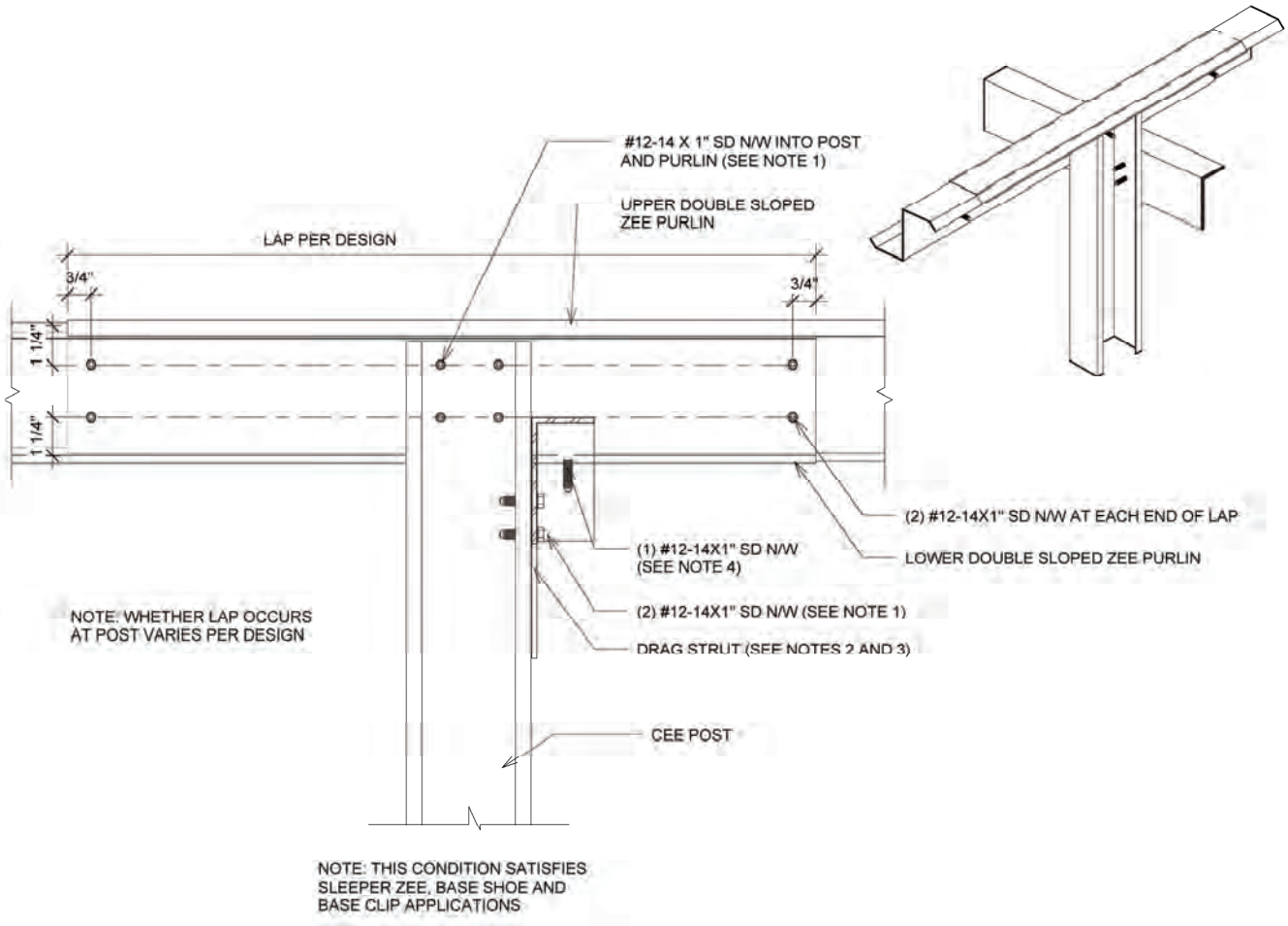


NOTE: THIS CONDITION SATISFIES SLEEPER ZEE, BASE SHOE AND BASE CLIP APPLICATIONS

NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. DRAG SRUT TO PURLIN FLANGE

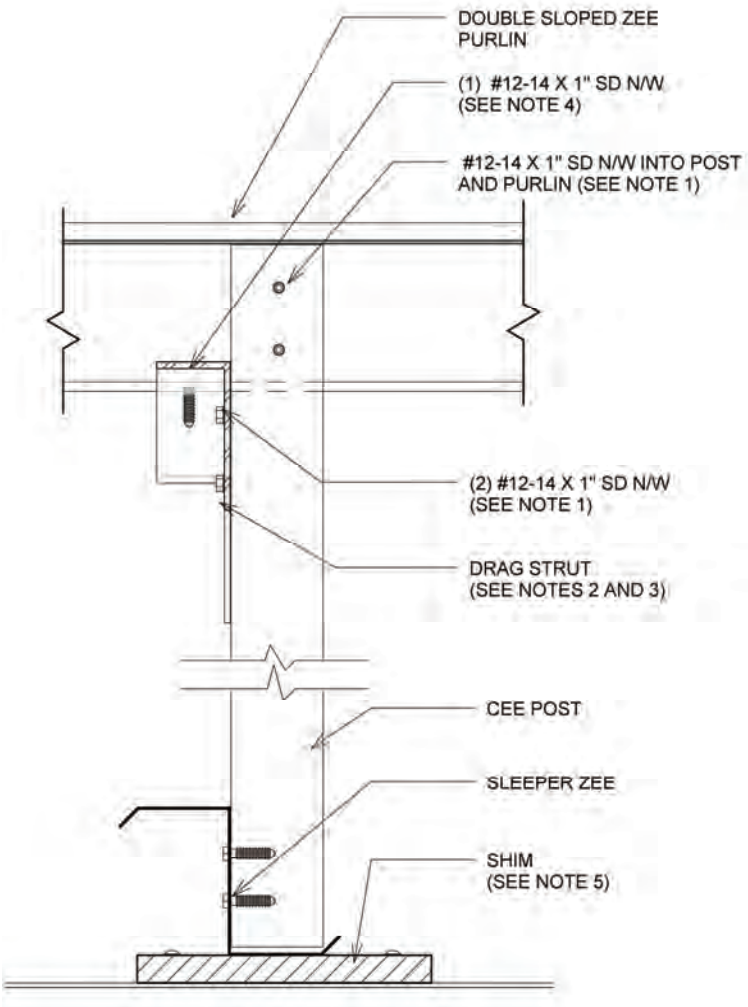
metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Double Sloped Purlin/ No Purlin Lap - All Bases

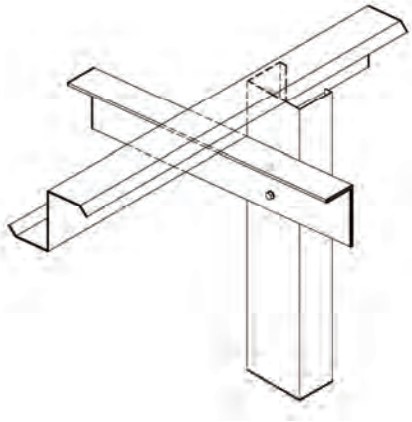


NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. DRAG SRUT TO PURLIN FLANGE

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Double Sloped Purlin/Purlin Lap – All Bases

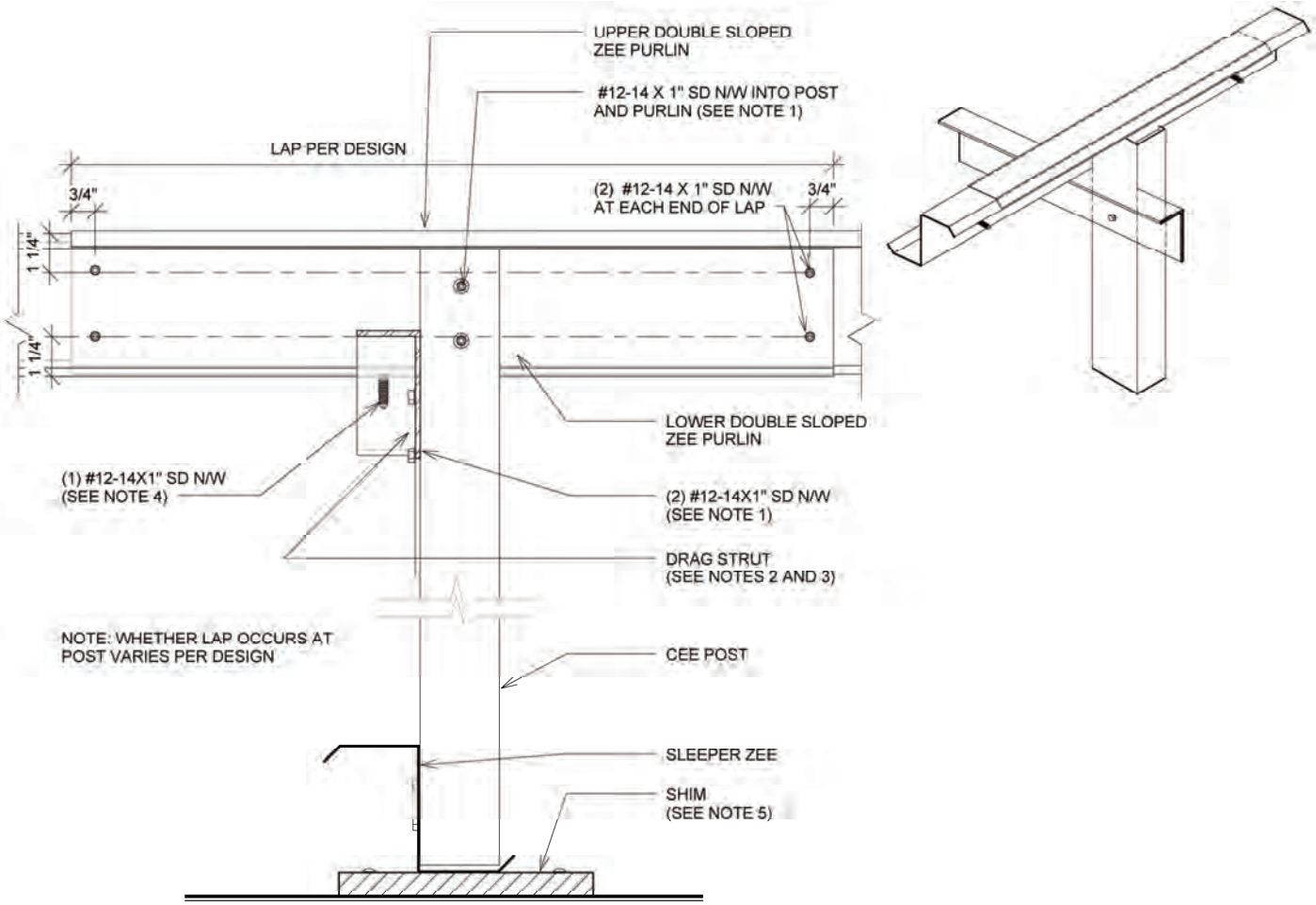




NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. DRAG STRUT TO FLANGE
5. NOT BY METAL SALES

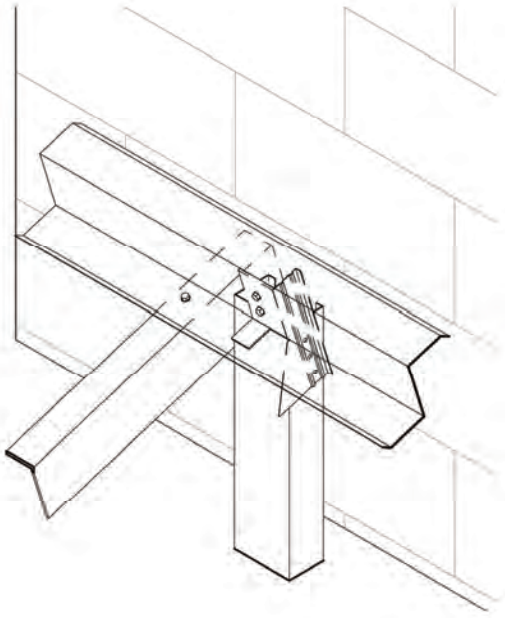
metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Double Sloped Purlin/ Sleeper Zee – No Purlin Lap

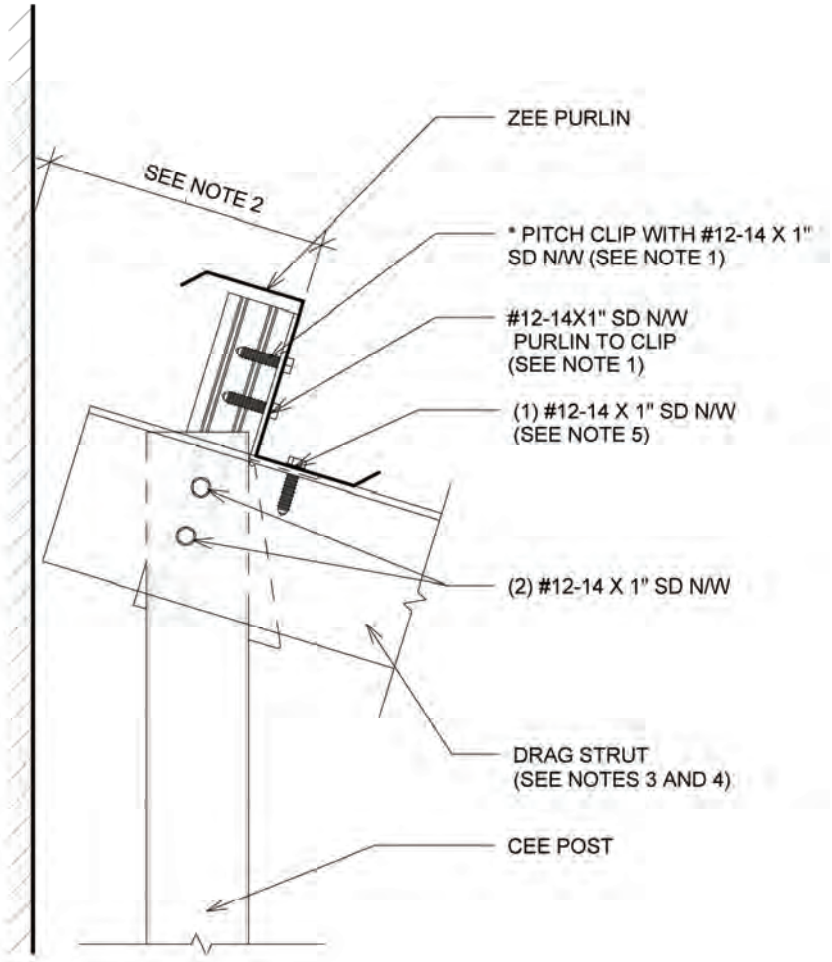


NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. DRAG STRUT TO PURLIN FLANGE
5. NOT BY METAL SALES

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Double Sloped Purlin/ Sleeper Zee/Purlin Lap





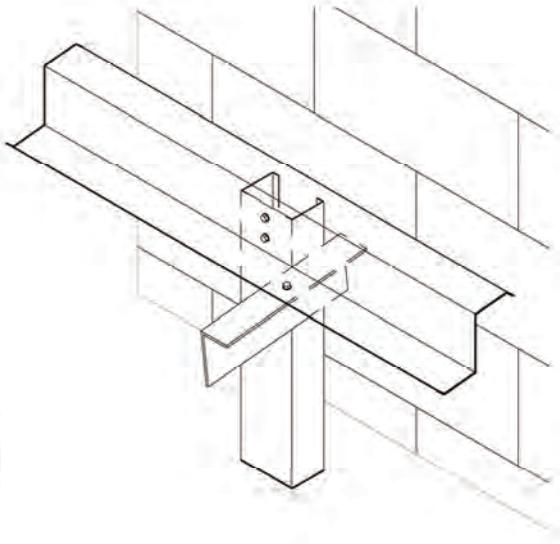
NOTE: THIS CONDITION SATISFIES SLEEPER ZEE, BASE SHOE AND BASE CLIP APPLICATIONS

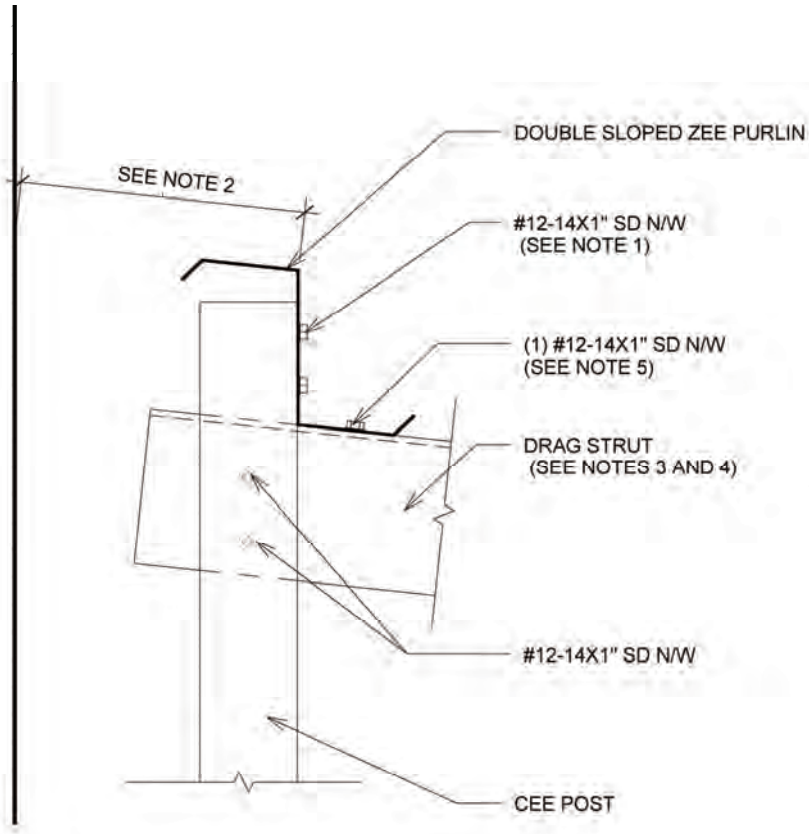
* PITCH CLIP IS PATENT PENDING

NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. PURLIN SETBACK VARIES WITH DESIGN
3. SPACING VARIES PER DESIGN
4. SIZE VARIES PER DESIGN
5. DRAG STRUT TO PURLIN FLANGE

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Roof to Wall/Pitch Clip – All Bases



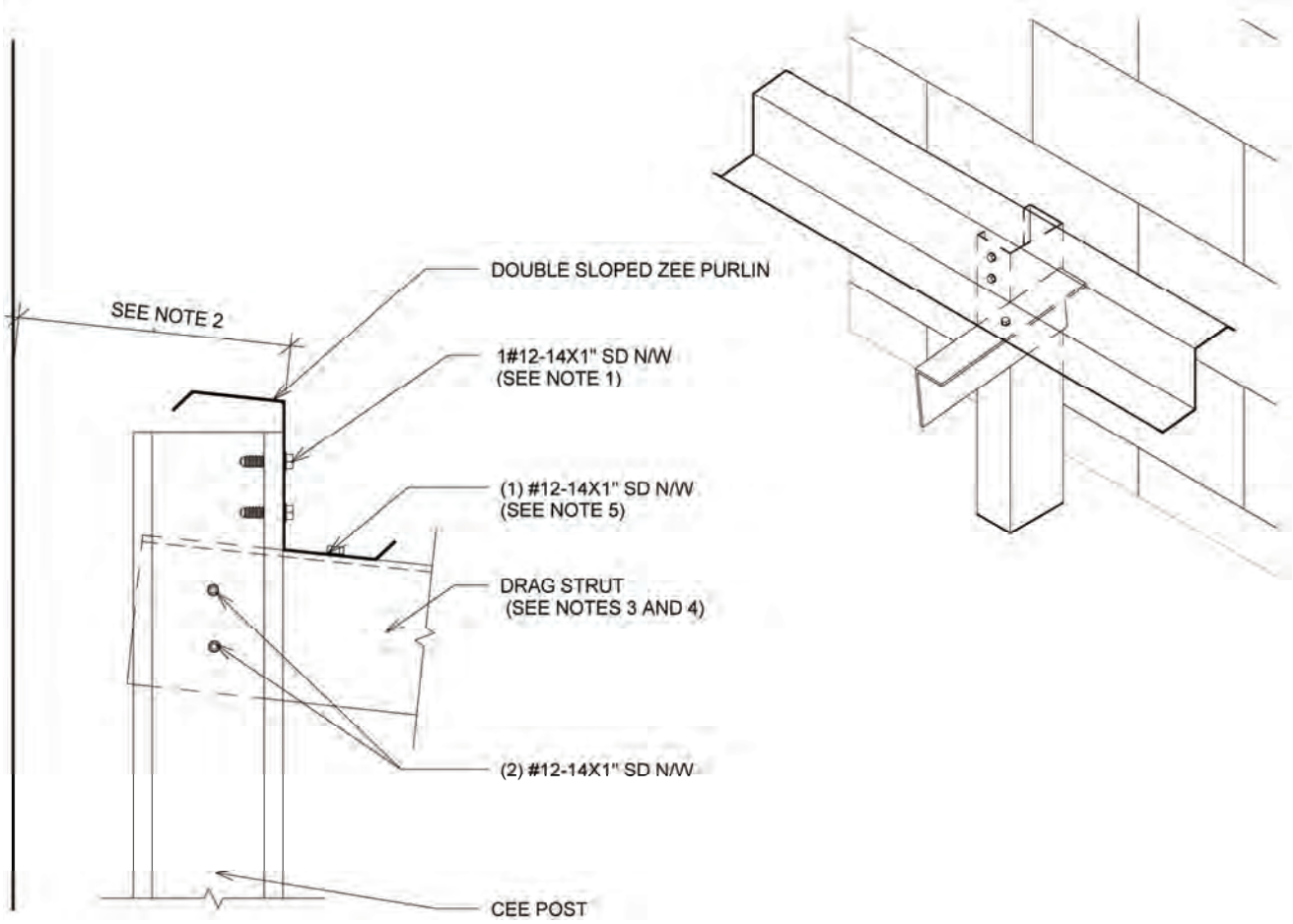


NOTE: THIS CONDITION SATISFIES SLEEPER ZEE, BASE SHOE AND BASE CLIP APPLICATIONS

NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. PURLIN SETBACK VARIES WITH DESIGN
3. SPACING VARIES PER DESIGN
4. SIZE VARIES PER DESIGN
5. DRAG STRUT TO PURLIN FLANGE

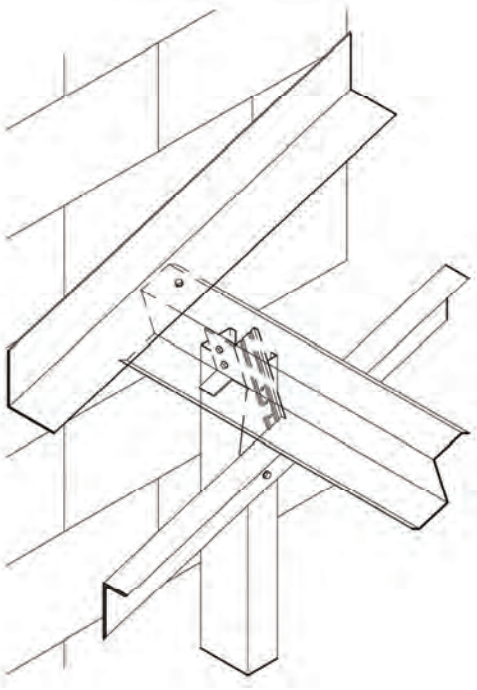
metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Roof to Wall/Double Sloped Purlin – All Bases

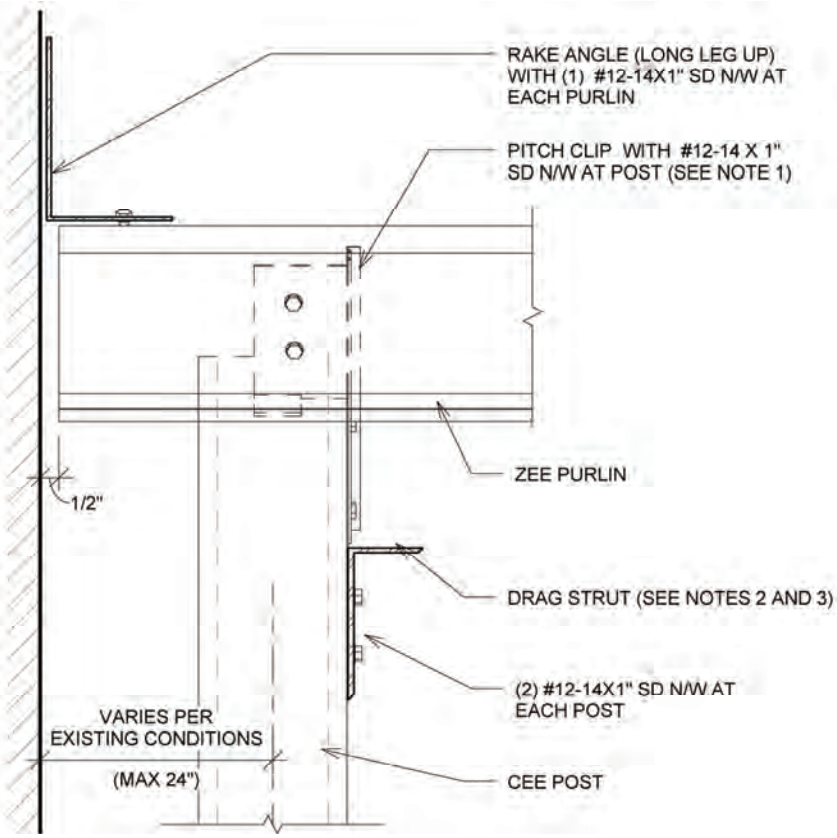


NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. PURLIN SETBACK VARIES WITH DESIGN
3. SPACING VARIES PER DESIGN
4. SIZE VARIES PER DESIGN
5. DRAG STRUT TO PURLIN FLANGE

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Rake to Wall/Double Sloped Purlin



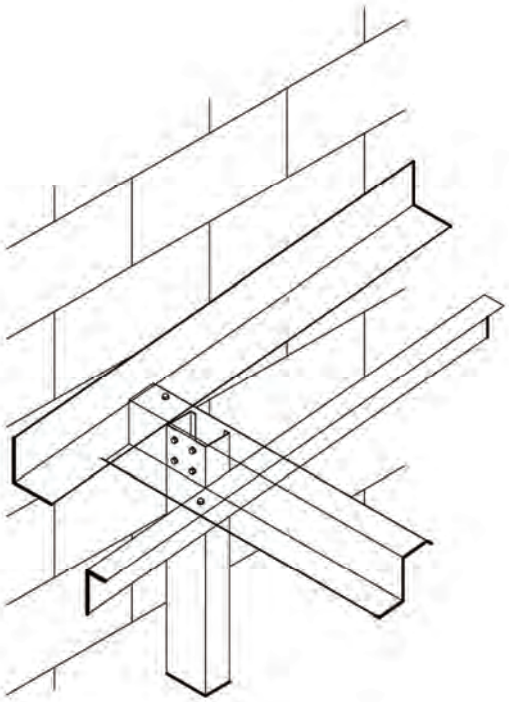


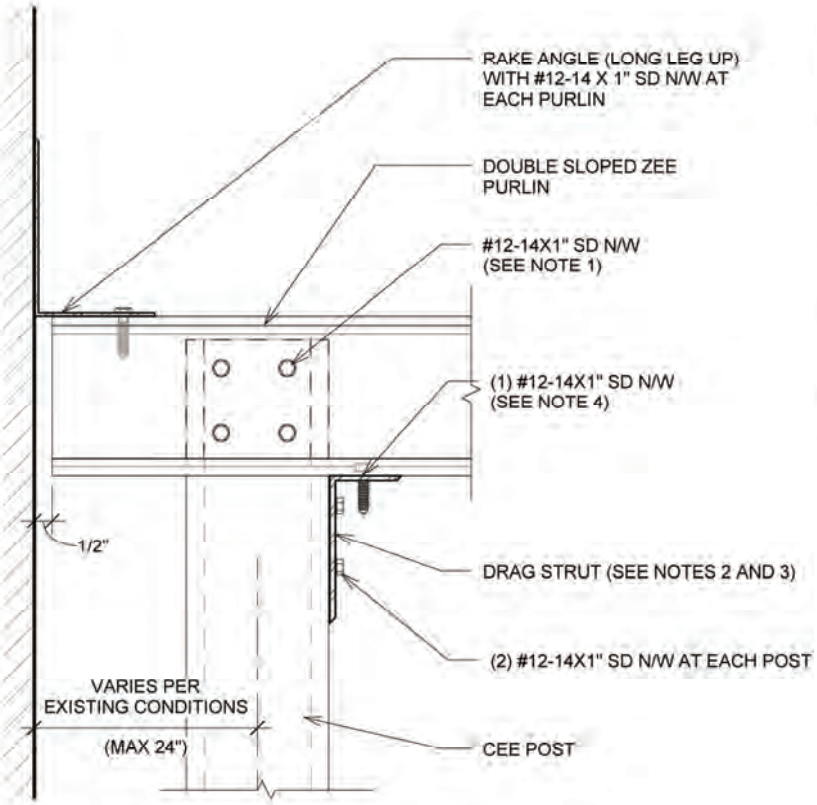
NOTE: THIS CONDITION SATISFIES SLEEPER ZEE BASE SHOE AND BASE CLIP APPLICATIONS

NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Rakewall/Pitch Clip – All Bases



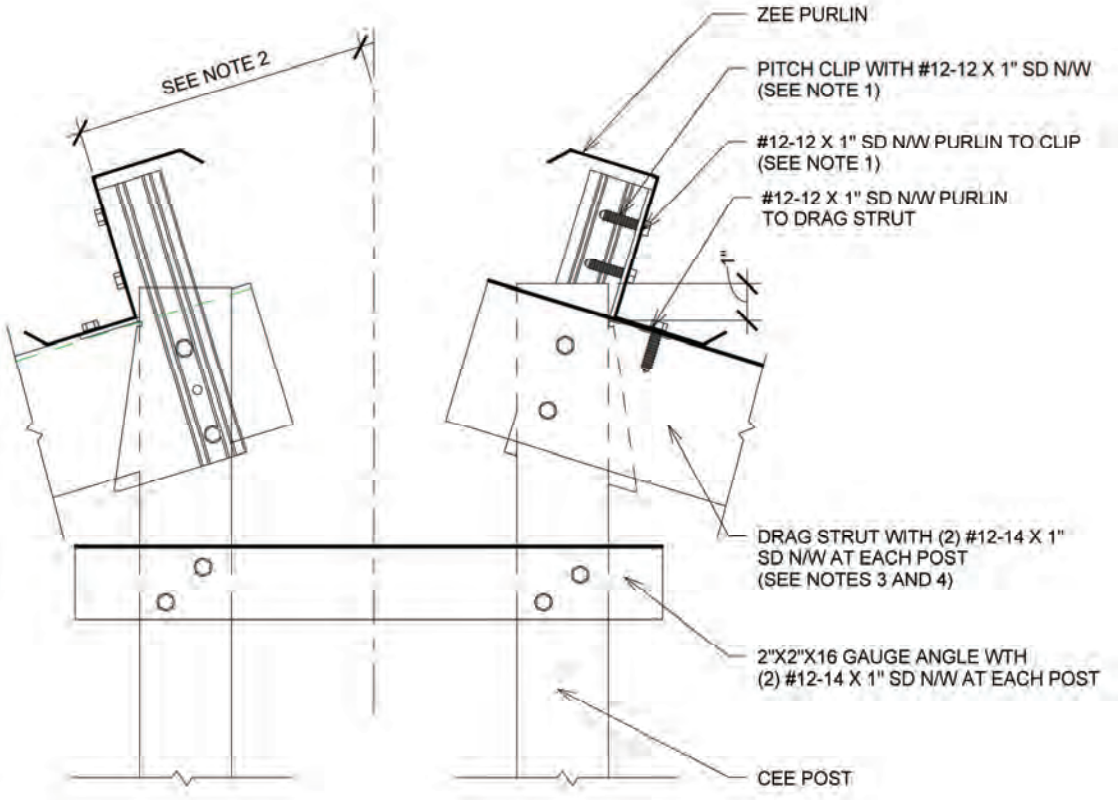


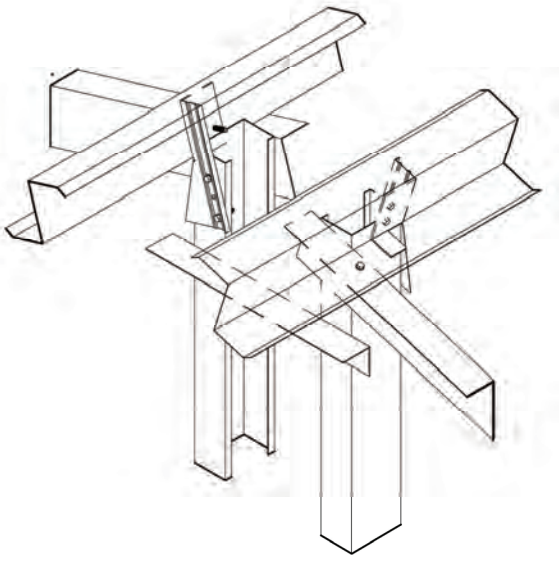
NOTE: THIS CONDITION SATISFIES SLEEPER ZEE, BASE SHOE AND BASE CLIP APPLICATIONS

NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. DRAG STRUT TO PURLIN FLANGE

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Rakewall/Double Sloped Purlin – All Bases

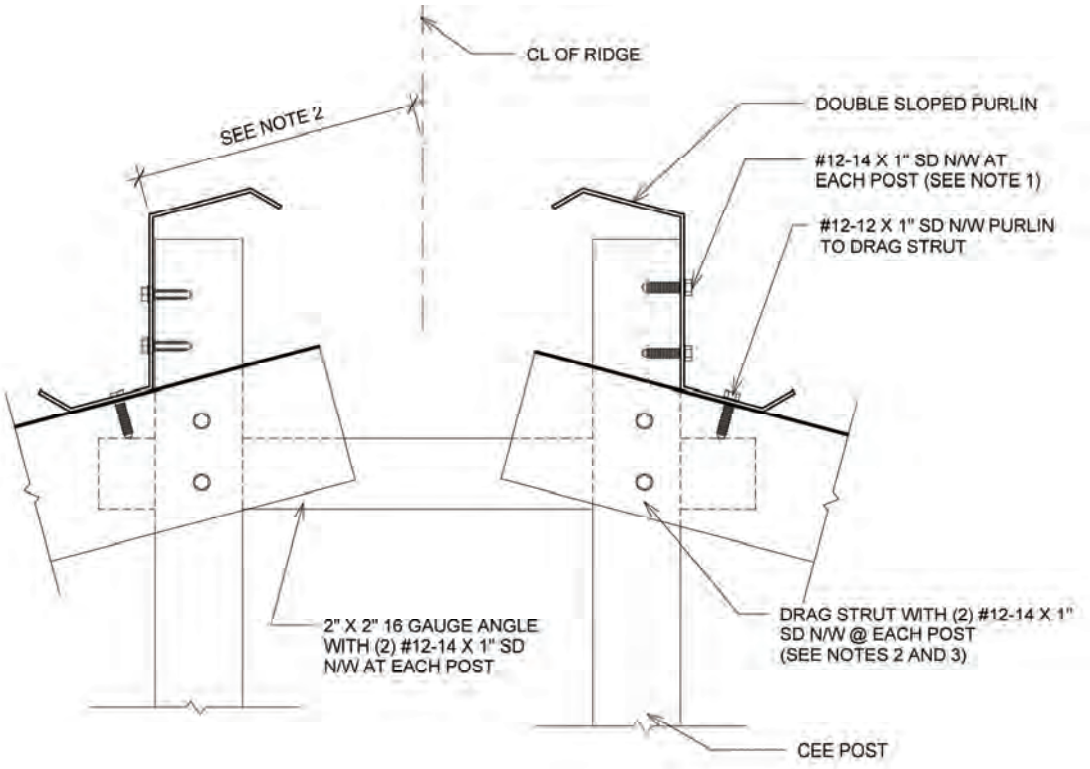


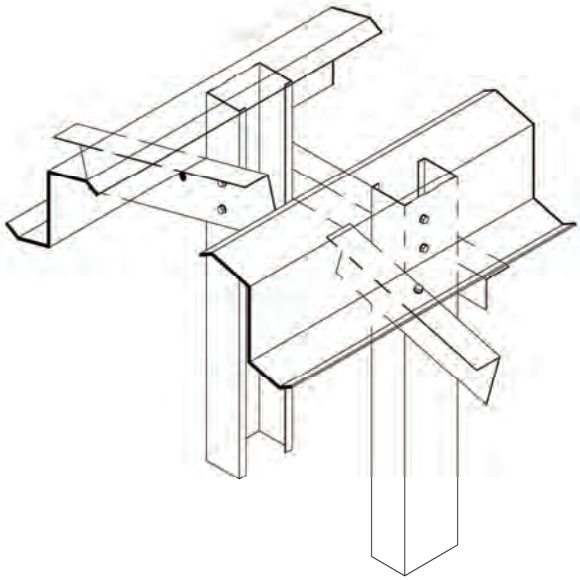


NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. PURLIN SETBACK VARIES WITH PANEL TYPE
3. SPACING VARIES PER DESIGN
4. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Ridge/Pitch Clip – All Bases

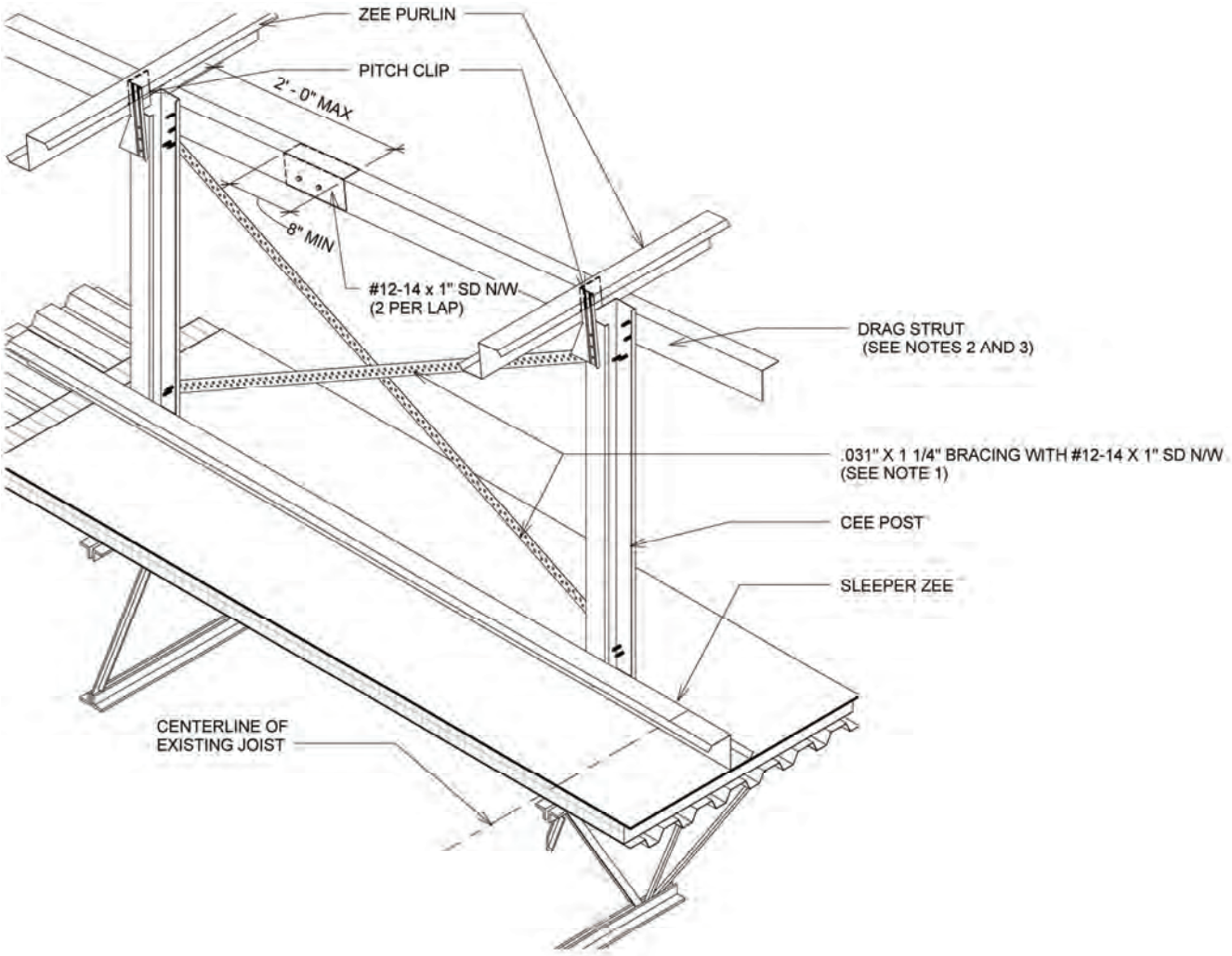


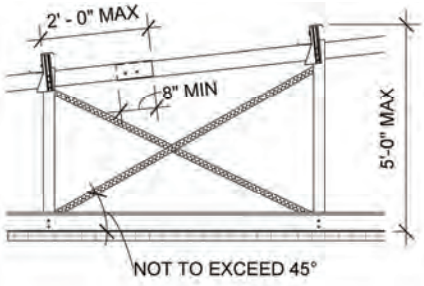


NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. PURLIN SETBACK VARIES WITH PANEL TYPE
3. SPACING VARIES PER DESIGN
4. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Post Detail – Ridge/Double Sloped Purlin – All Bases

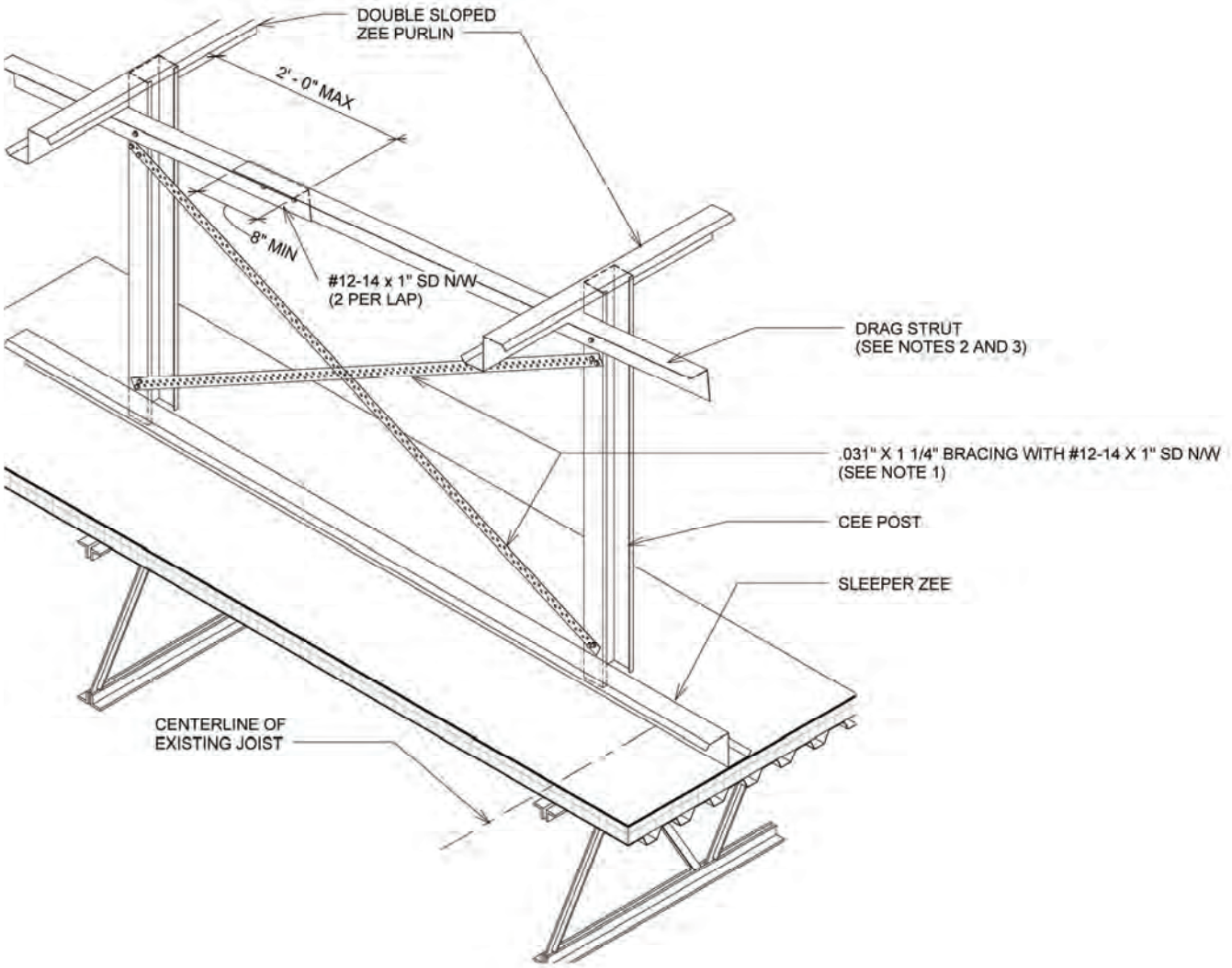


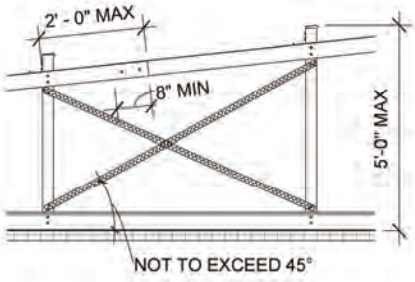


NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Transverse Bracing - Pitch Clip/Sleeper Zee - Perpendicular

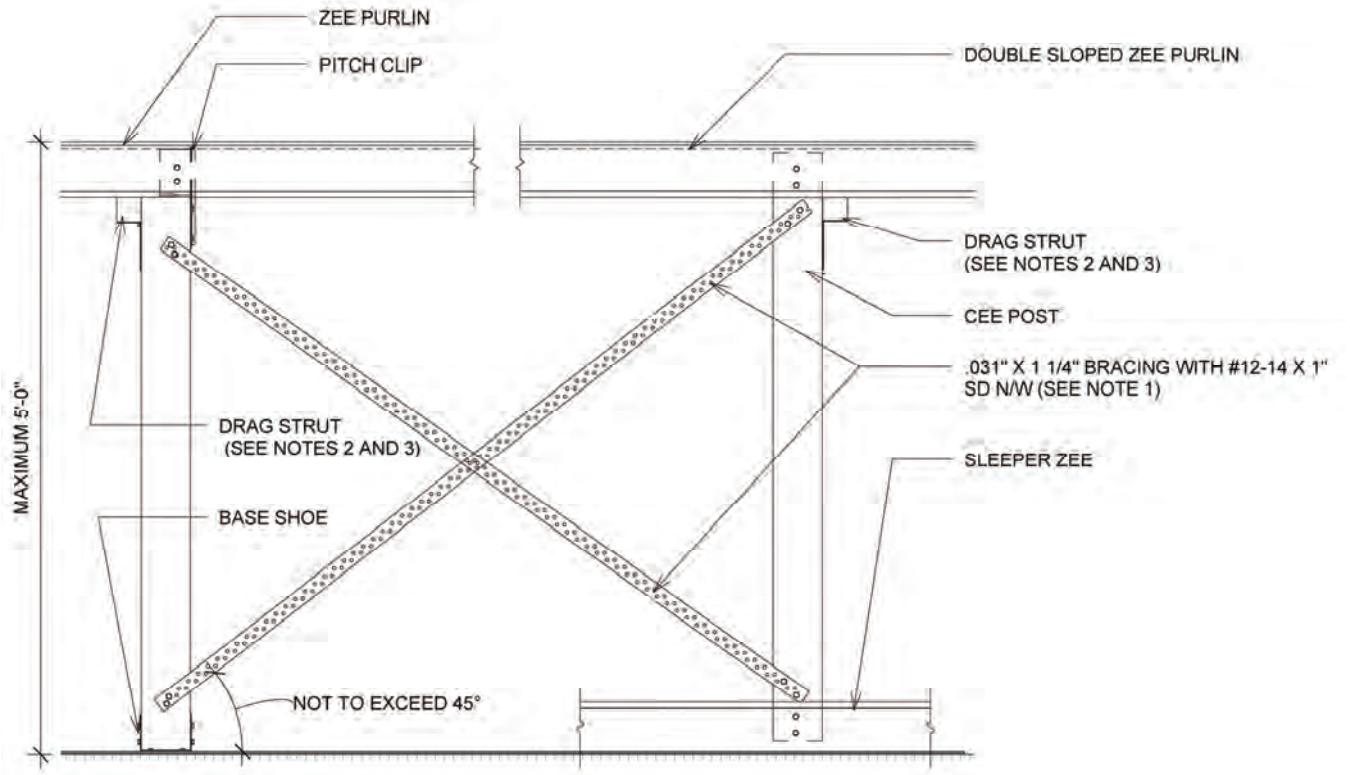




NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN

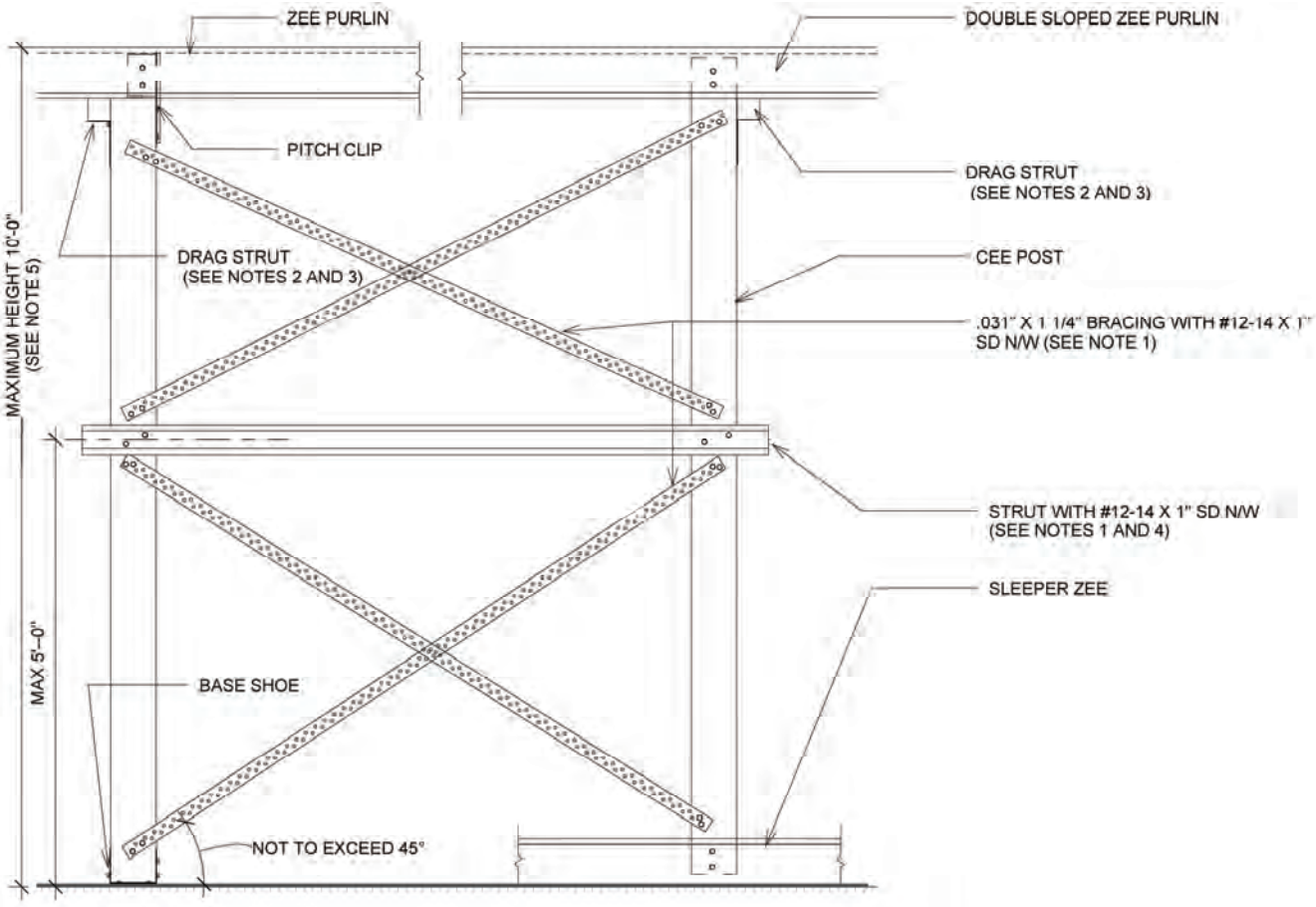
metal sales manufacturing corporation	Date 5/15/2013	Transverse Bracing-Double Sloped Purlin/ Sleeper Zee - Perpendicular



NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Longitudinal Single High Bracing



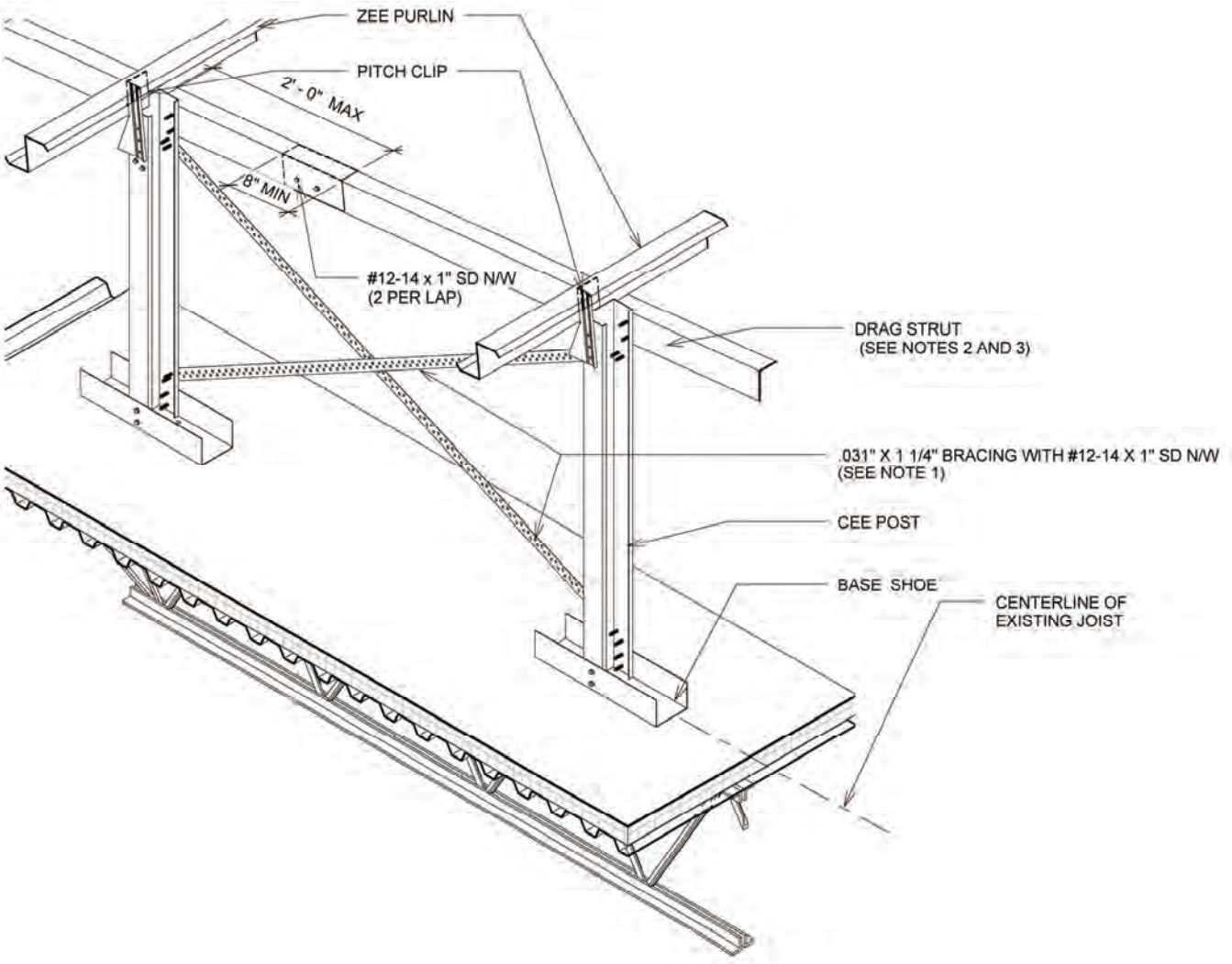
PITCH CLIP WITH BASE SHOE

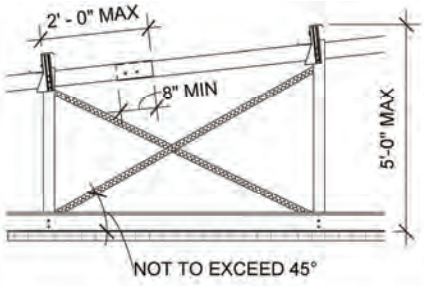
DOUBLE SLOPED ZEE
PURLIN WITH SLEEPER ZEE

NOTES:

1. QUANTITY OF FASTENERS VARY WITH DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. TYPE AND SIZE VARIES PER DESIGN
5. FOR POST HEIGHTS EXCEEDING 10'-0", MEMBER TYPES AND SIZES VARY PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Longitudinal Double High Bracing

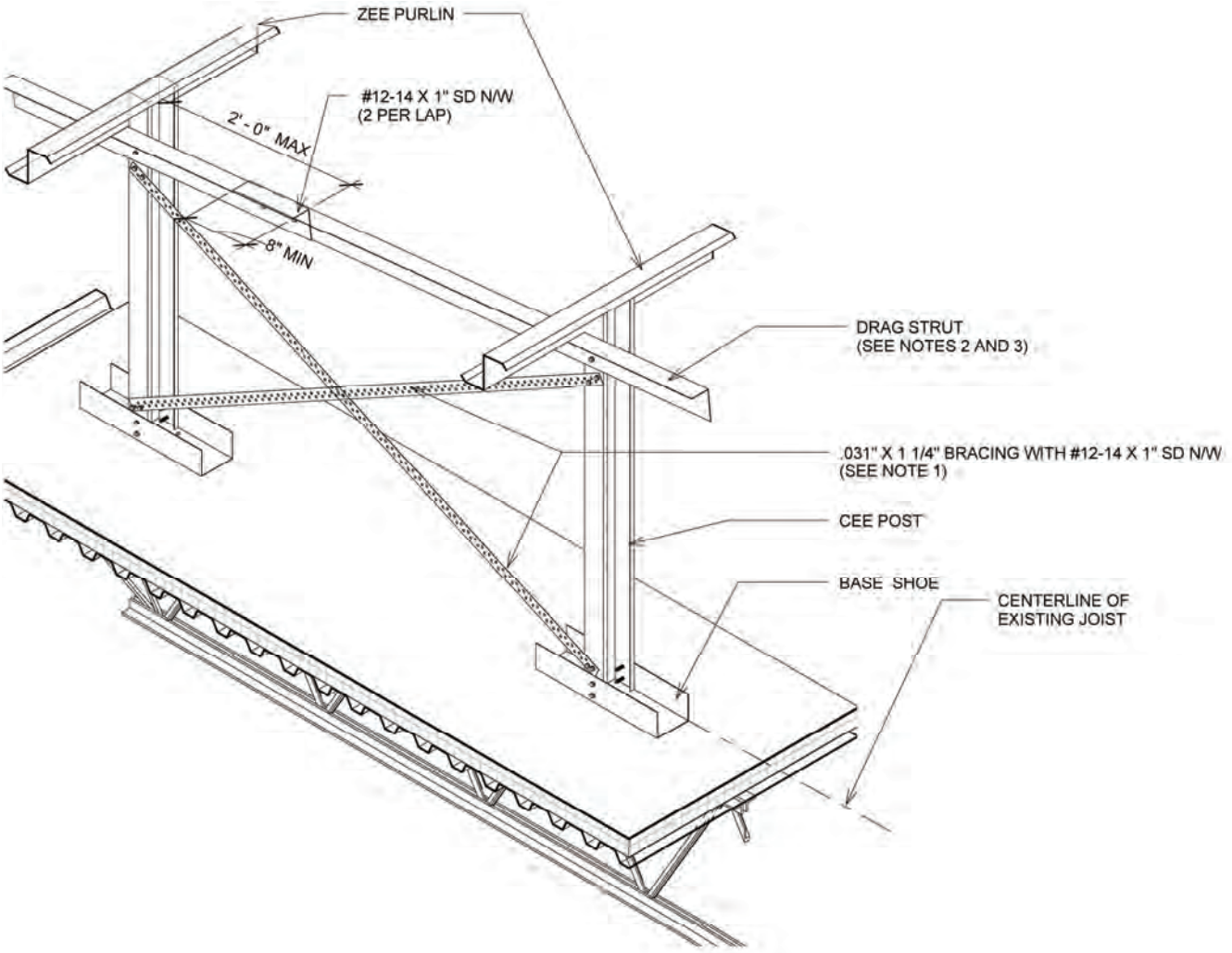


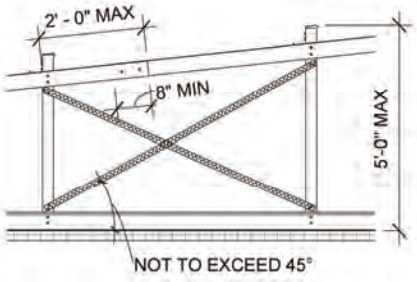


NOTES:

1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Transverse Bracing-Pitch Clip/ Base Clip - Parallel

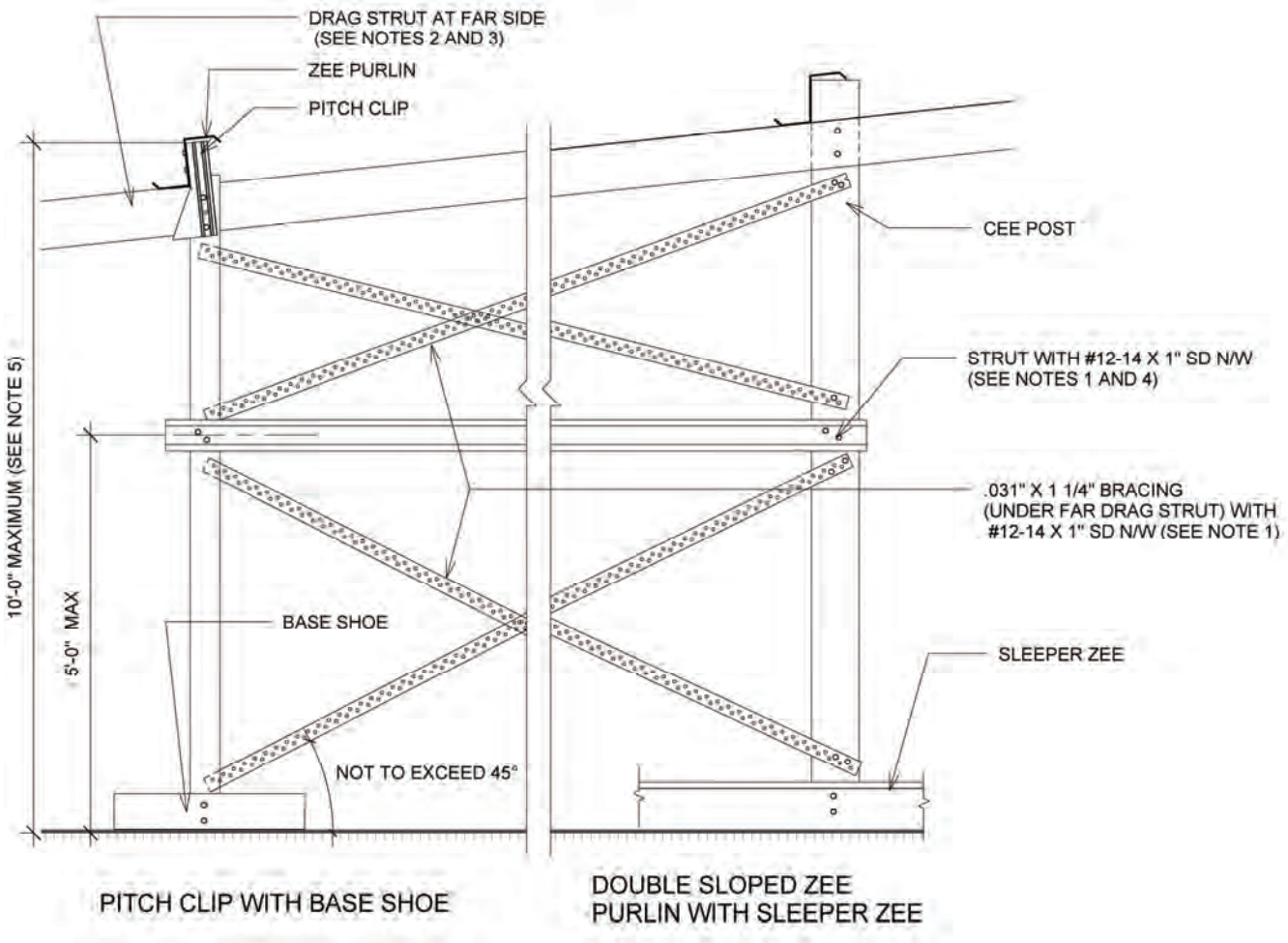




NOTES:

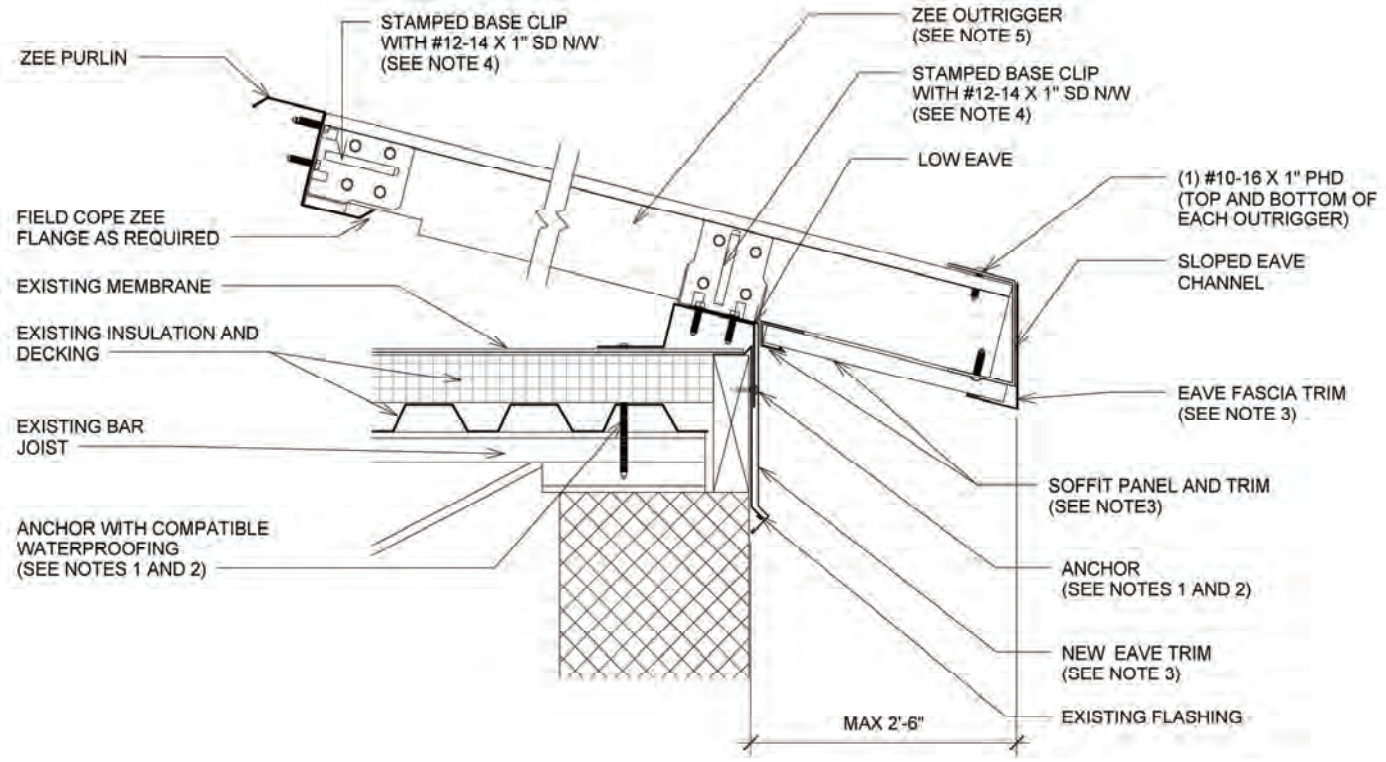
1. QUANTITY OF FASTENERS VARY PER DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Transverse Bracing – Double Sloped Purlin/ Base Shoe - Parallel



NOTES:
1. QUANTITY OF FASTENERS VARIES WITH DESIGN
2. SPACING VARIES PER DESIGN
3. SIZE VARIES PER DESIGN
4. TYPE AND SIZE VARIES PER DESIGN
5. FOR POST HEIGHTS EXCEEDING 10'-0", MEMBER TYPES AND SIZES VARY PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Double High Transverse Lateral Bracing

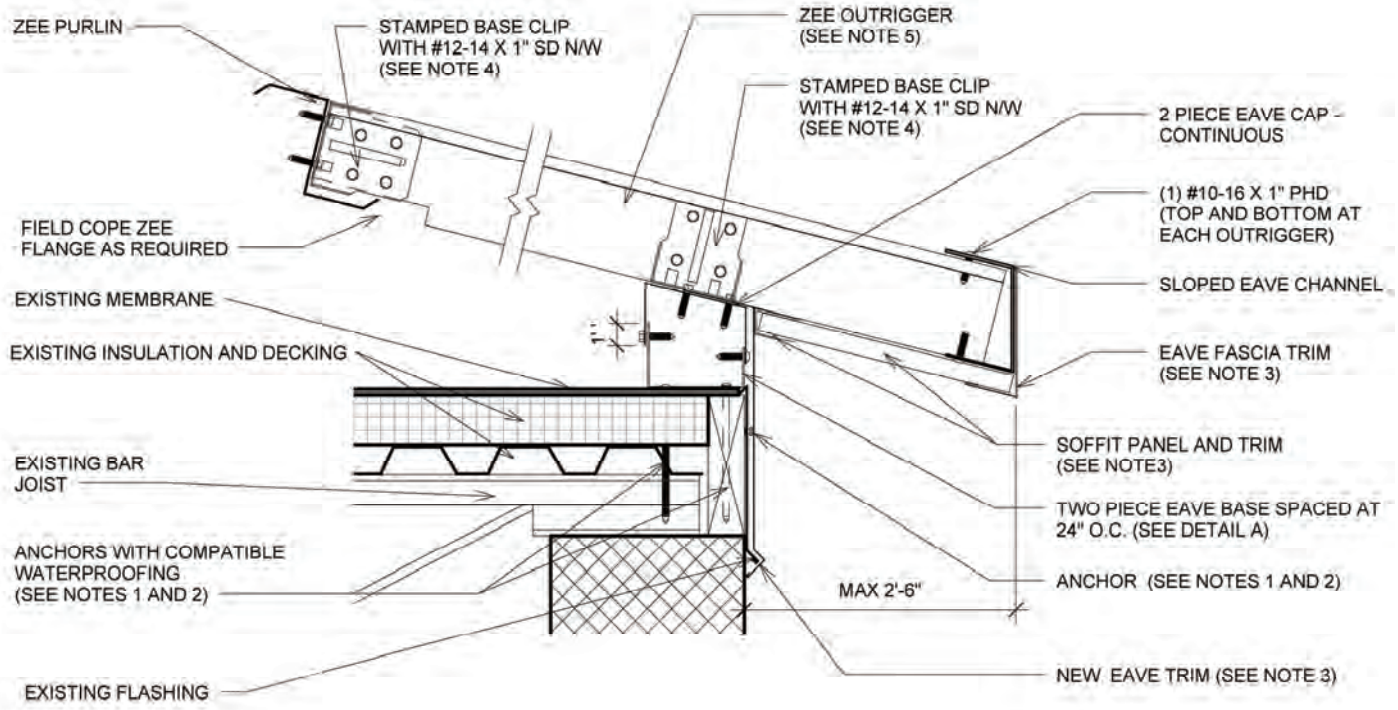


NOTE: FRAMING MEMBER SHAPE, SIZE AND THICKNESS ARE PER METAL SALES DESIGN

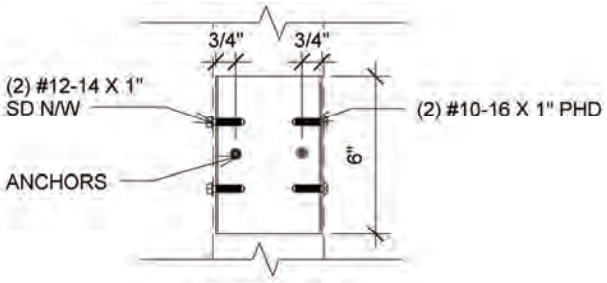
NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. QUANTITY OF FASTENERS VARY PER DESIGN
5. SPACING VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Low Eave Overhang/Canopy



NOTE: FRAMING MEMBER SHAPE, SIZE AND THICKNESS ARE PER METAL SALES DESIGN

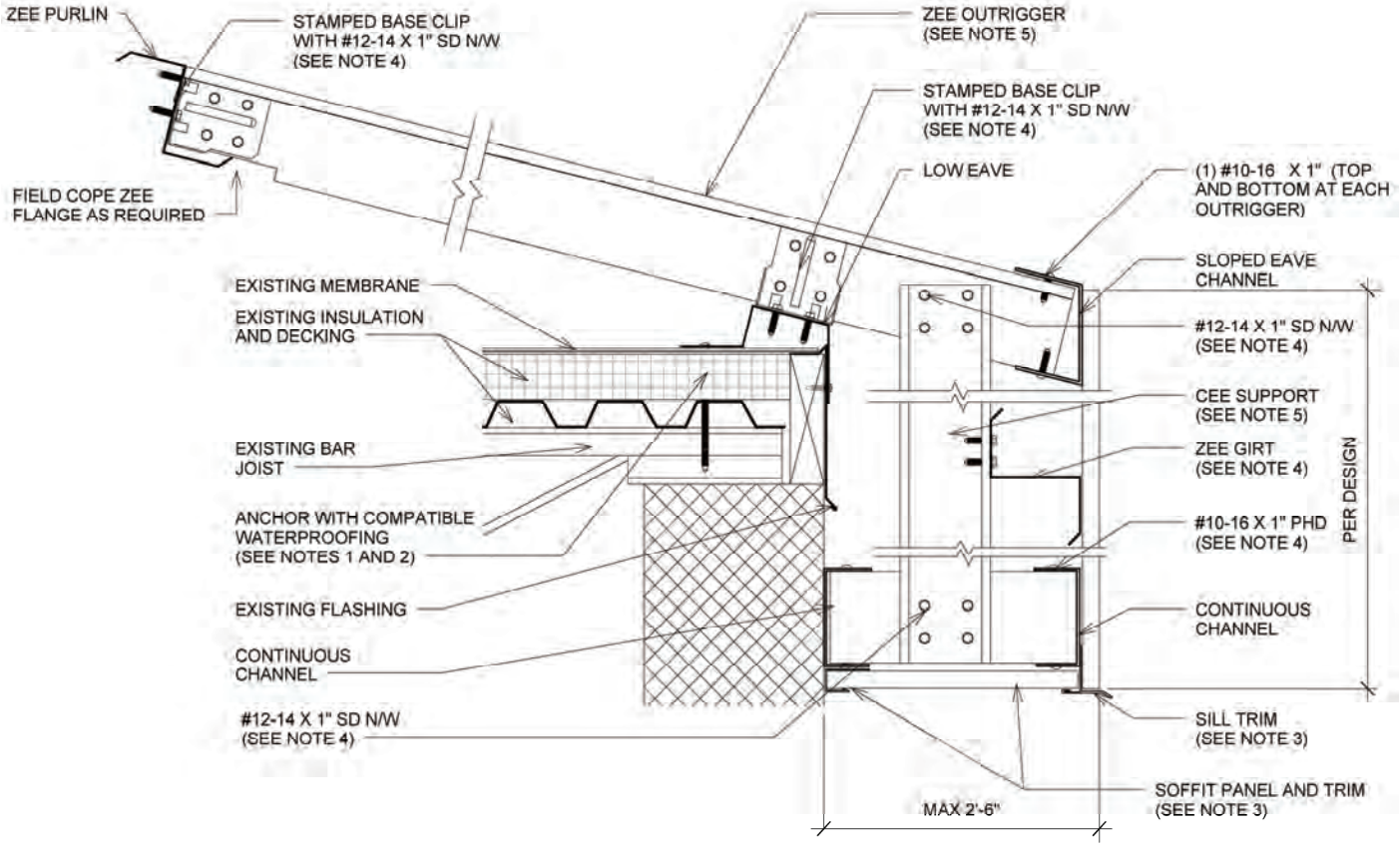


DETAIL A

NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. QUANTITY OF FASTENERS VARY PER DESIGN
5. SPACING VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Low Two Piece Eave Overhang/Canopy

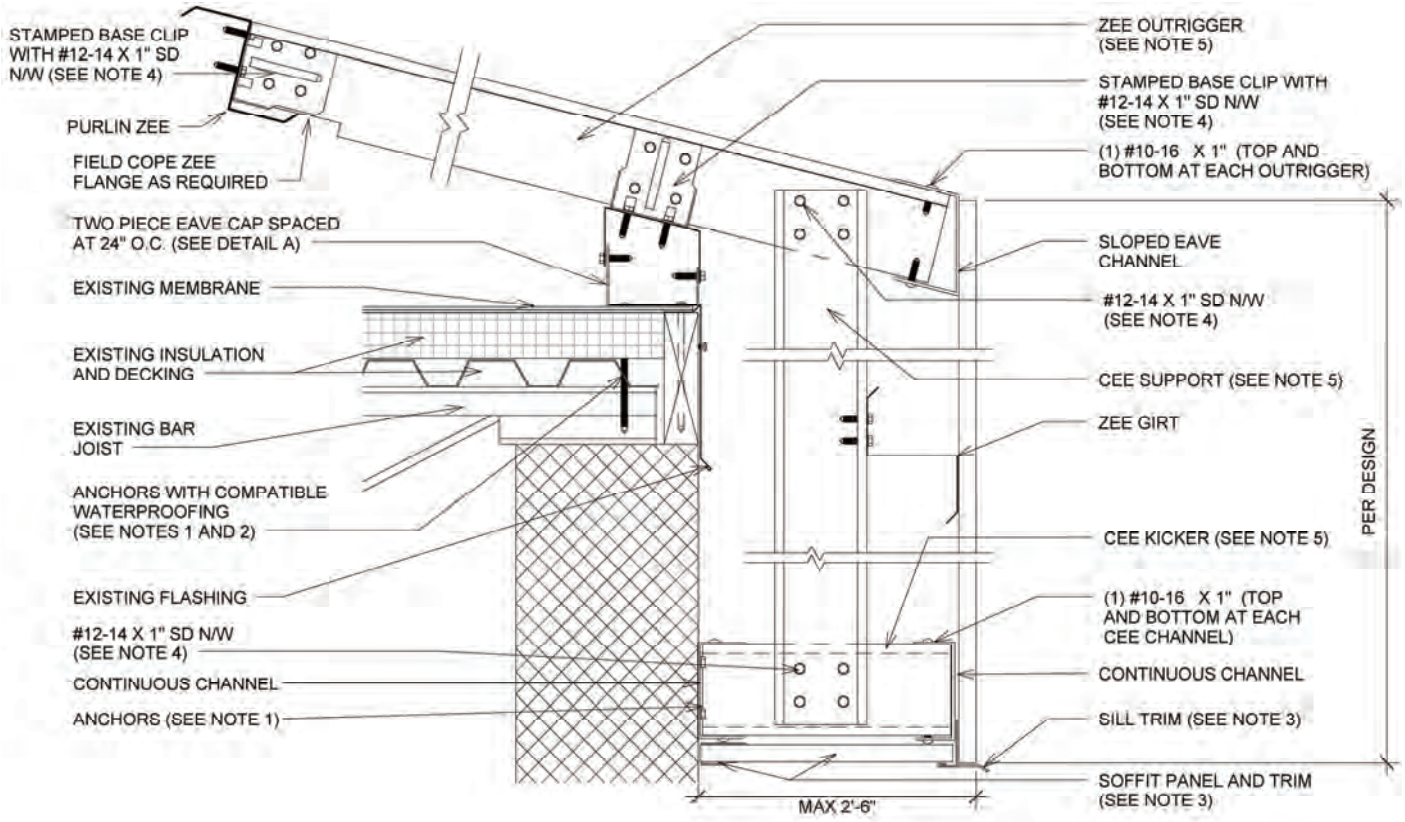


NOTE: FRAMING MEMBER SHAPE, SIZE AND THICKNESS ARE PER METAL SALES DESIGN

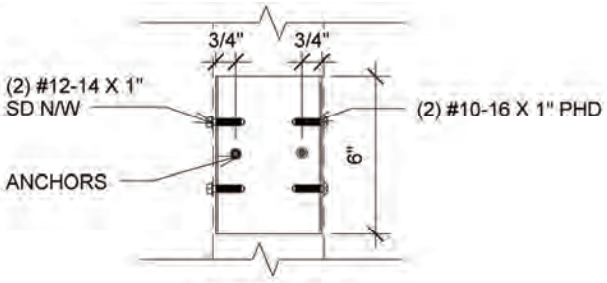
NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. QUANTITY OF FASTENERS VARY PER DESIGN
5. SPACING VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Low Eave/Dropped Fascia



NOTE: FRAMING MEMBER SHAPE, SIZE AND THICKNESS ARE PER METAL SALES DESIGN

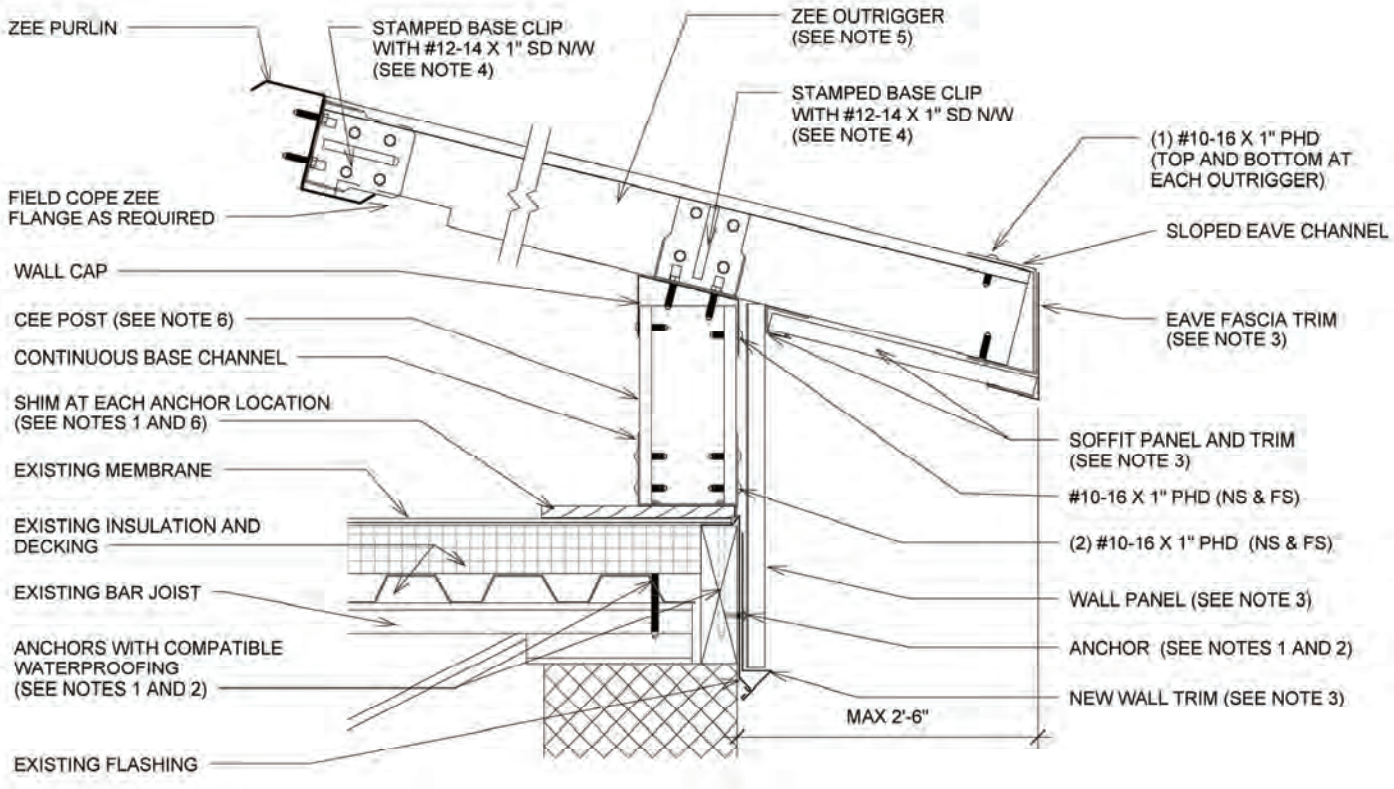


DETAIL A

NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. QUANTITY OF FASTENERS VARY PER DESIGN
5. SPACING VARIES PER DESIGN

metal sales manufacturing corporation	Date 5/15/2013	Low Two Piece Eave/Dropped Fascia

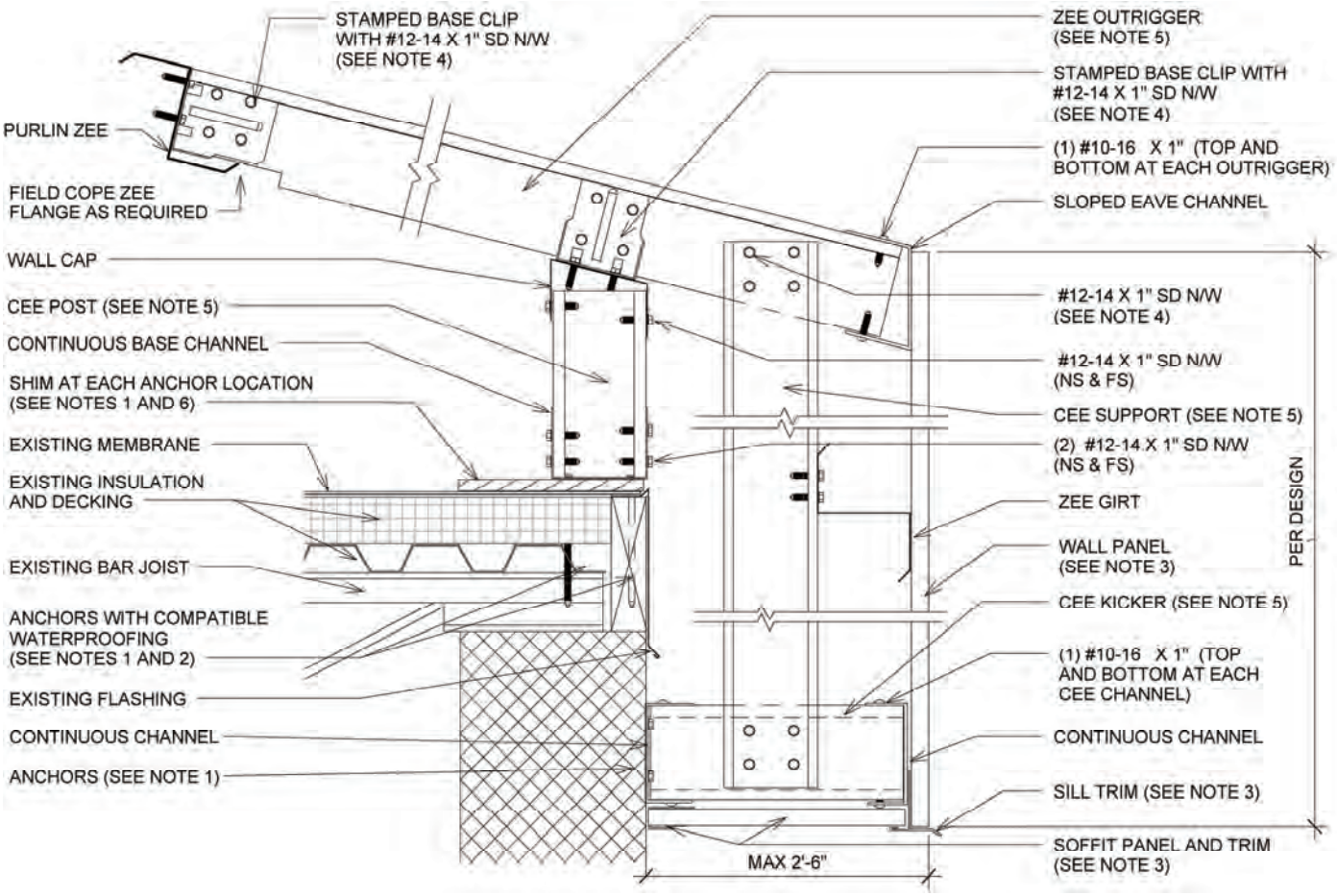


NOTE: FRAMING MEMBER SHAPE, SIZE AND THICKNESS ARE PER METAL SALES DESIGN

NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. QUANTITY OF FASTENERS VARY PER DESIGN
5. SPACING VARIES PER DESIGN
6. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Elevated Eave Wall Overhang/Canopy

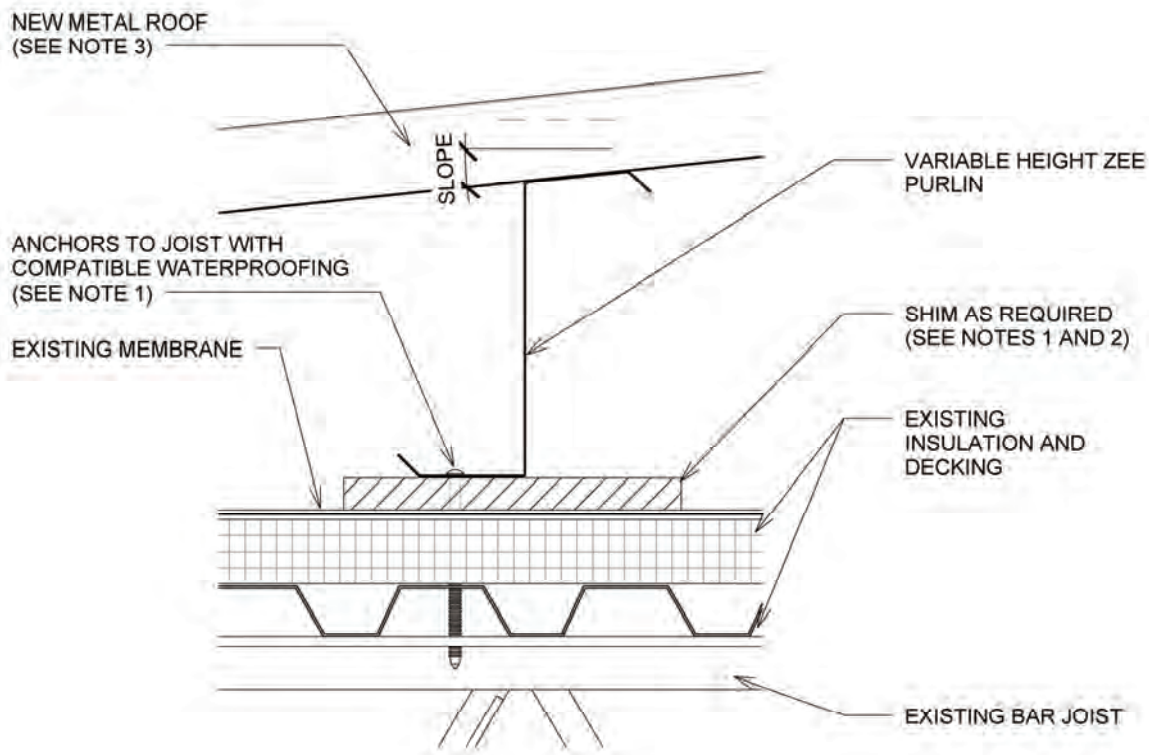


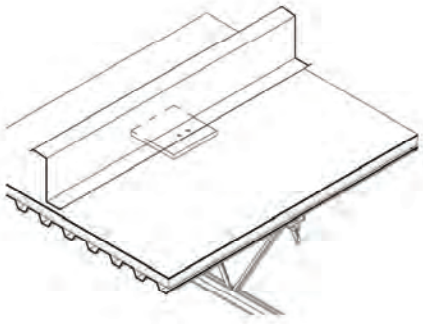
NOTE: FRAMING MEMBER SHAPE, SIZE AND THICKNESS ARE PER METAL SALES DESIGN

NOTES:

1. NOT FURNISHED BY METAL SALES
2. ANCHOR SPACING NOT TO EXCEED 24" O.C.
3. SEE PANEL DETAILS FOR ATTACHMENT
4. QUANTITY OF FASTENERS VARY PER DESIGN
5. SPACING VARIES PER DESIGN
6. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Elevated Eave Wall/Dropped Fascia

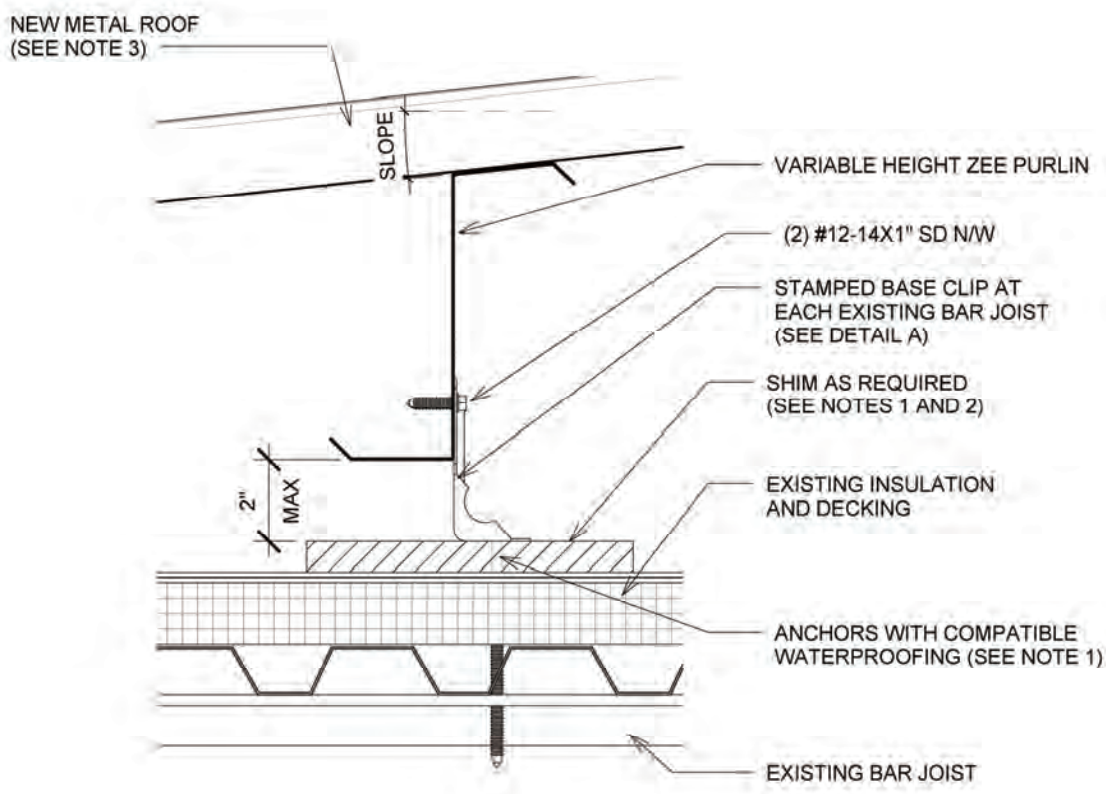


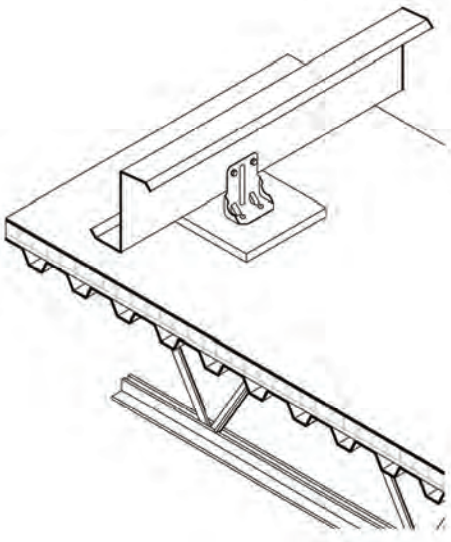


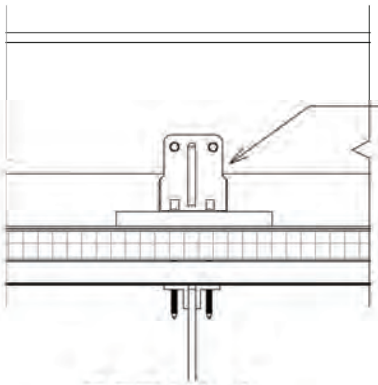
NOTES:

1. NOT FURNISHED BY METAL SALES
2. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
3. SEE PANEL DETAILS FOR ATTACHMENT

metal sales manufacturing corporation	Date 5/15/2013	Variable Height Zee Purlin





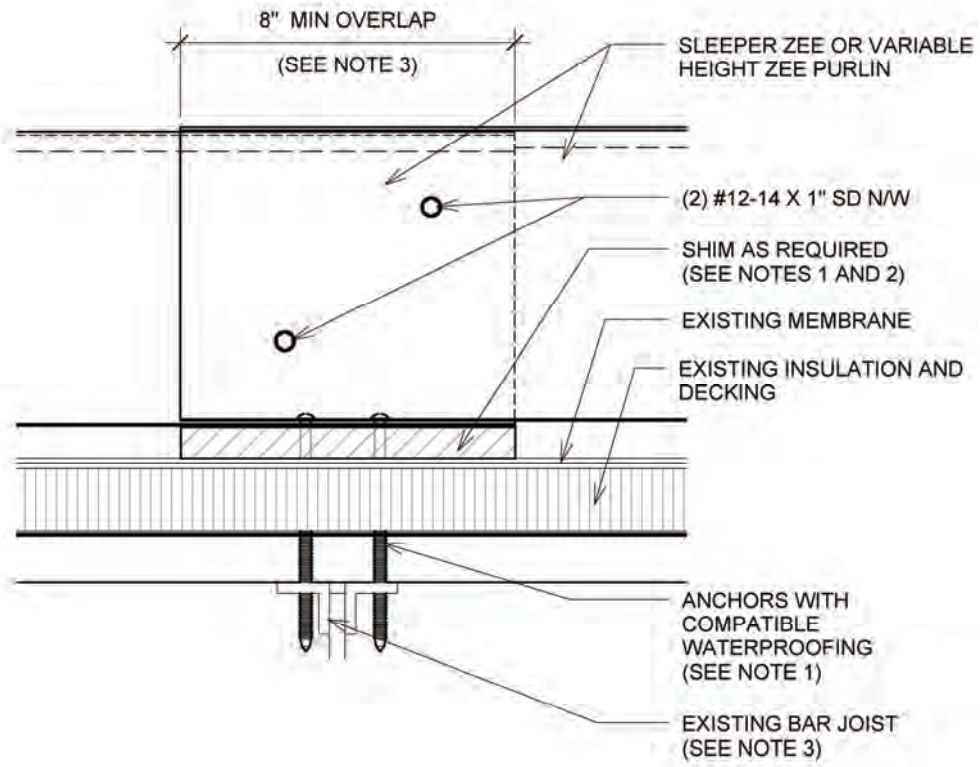


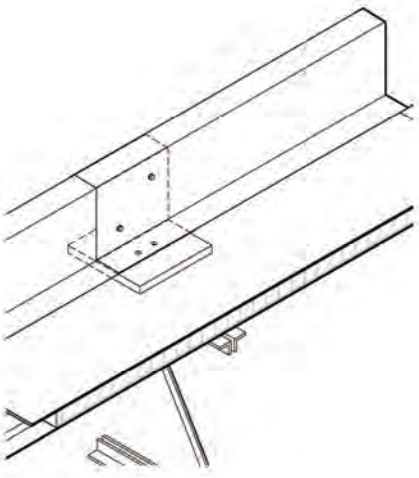
DETAIL A

NOTES:

1. NOT FURNISHED BY METAL SALES
2. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
3. SEE PANEL DETAILS FOR ATTACHMENT

metal sales manufacturing corporation	Date 5/15/2013	Variable Height Zee Purlin/Base Clip

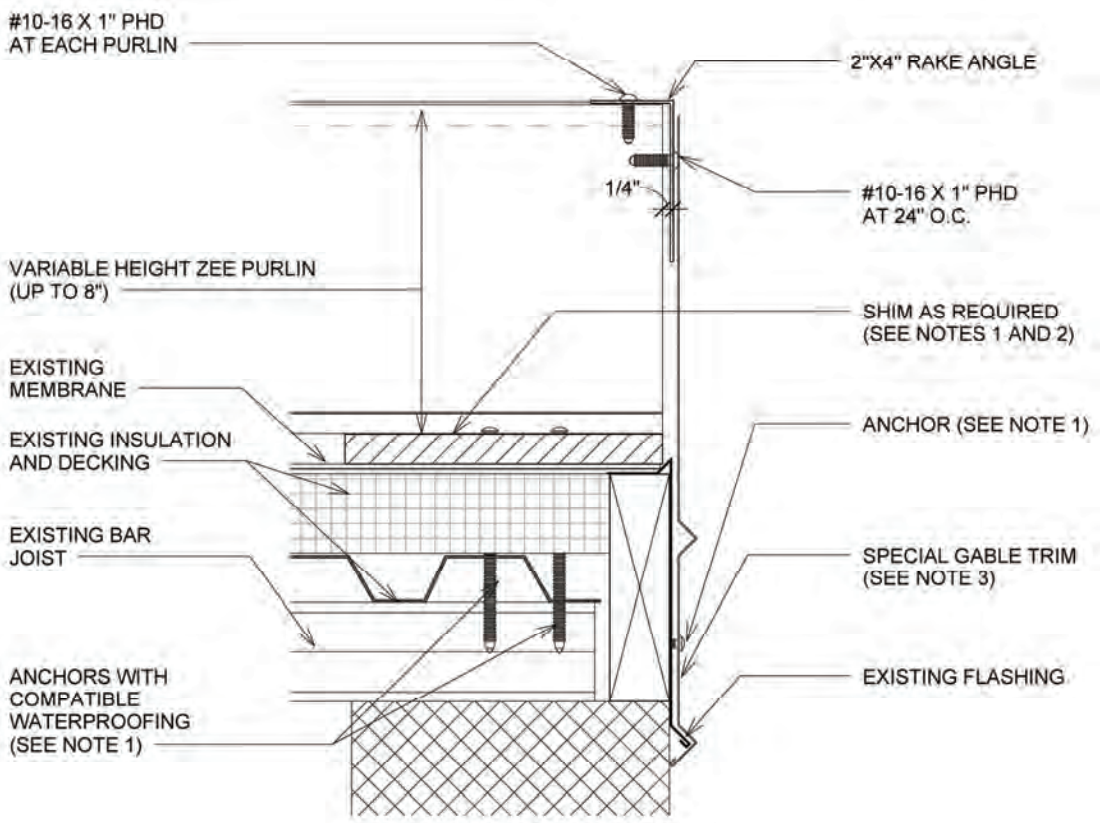


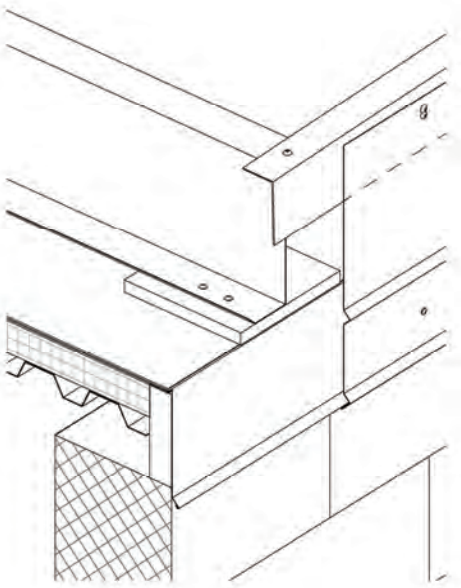


NOTES:

1. NOT FURNISHED BY METAL SALES
2. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
3. LAP DOES NOT HAVE TO OCCUR OVER BAR JOIST

metal sales manufacturing corporation	Date 5/15/2013	Lap of Sleeper Zee or Variable Height Zee Purlin

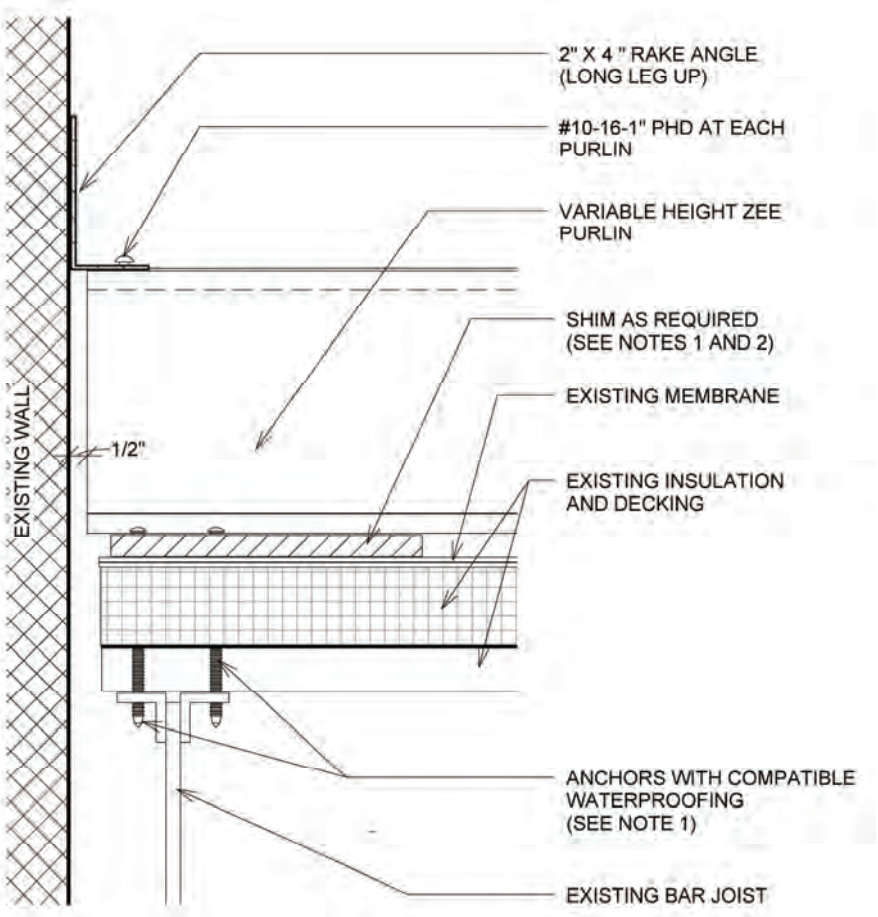


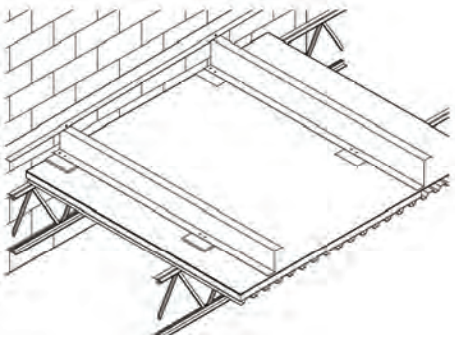


NOTES:

1. NOT FURNISHED BY METAL SALES
2. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
3. SEE PANEL DETAILS FOR ATTACHMENT

metal sales manufacturing corporation	Date 5/15/2013	Variable Height Zee Purlin at Gable

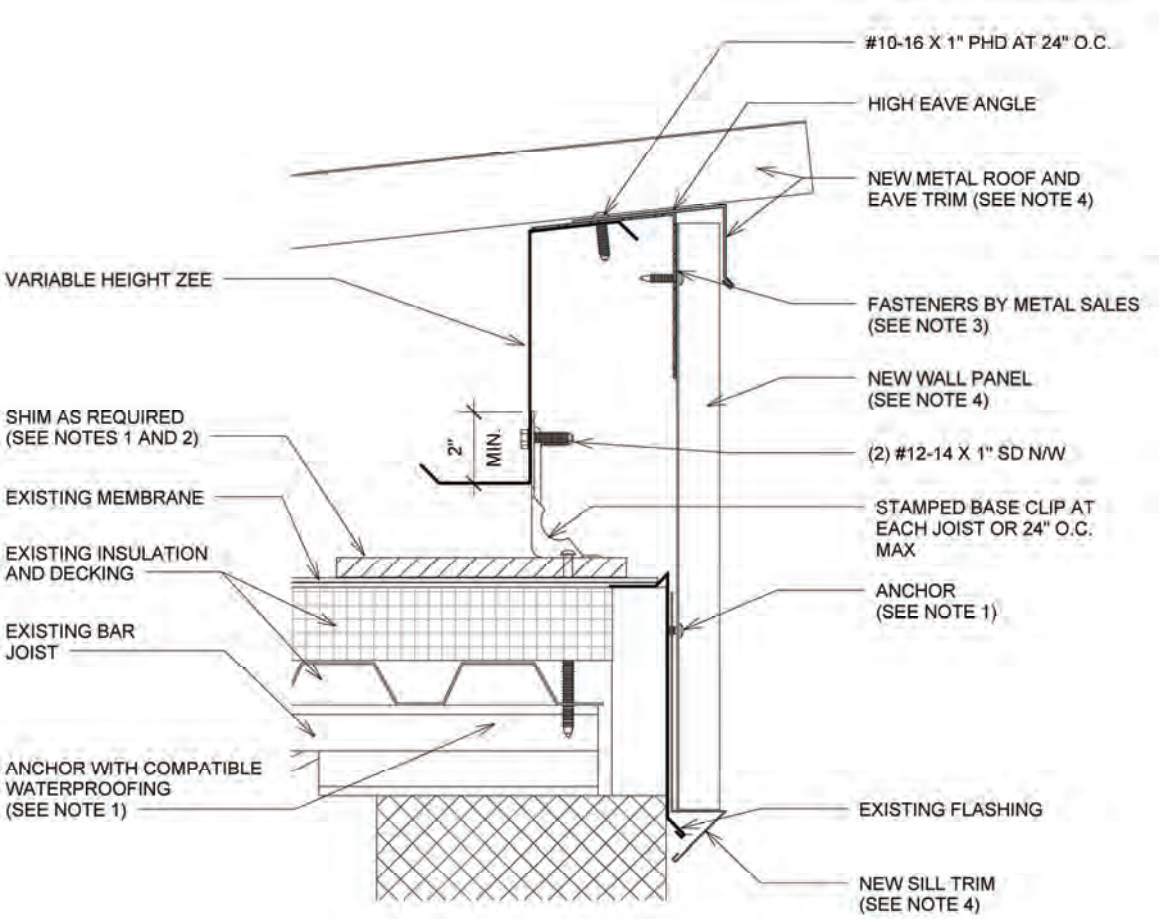


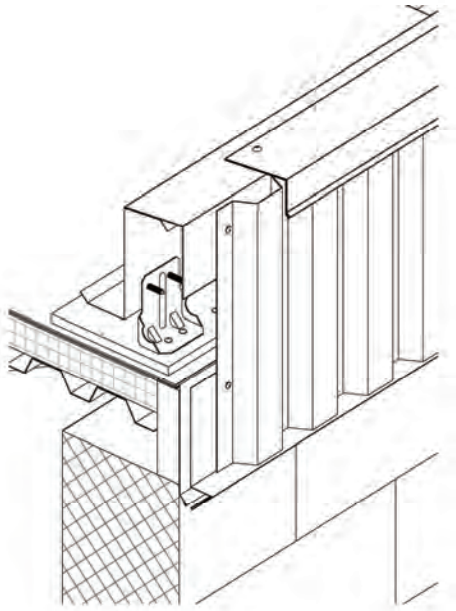


NOTES:

1. NOT FURNISHED BY METAL SALES
2. SHIM TO PROVIDE ADEQUATE BEARING SURFACE

metal sales manufacturing corporation	Date 5/15/2013	Variable Height Zee Purlin/Rakewall

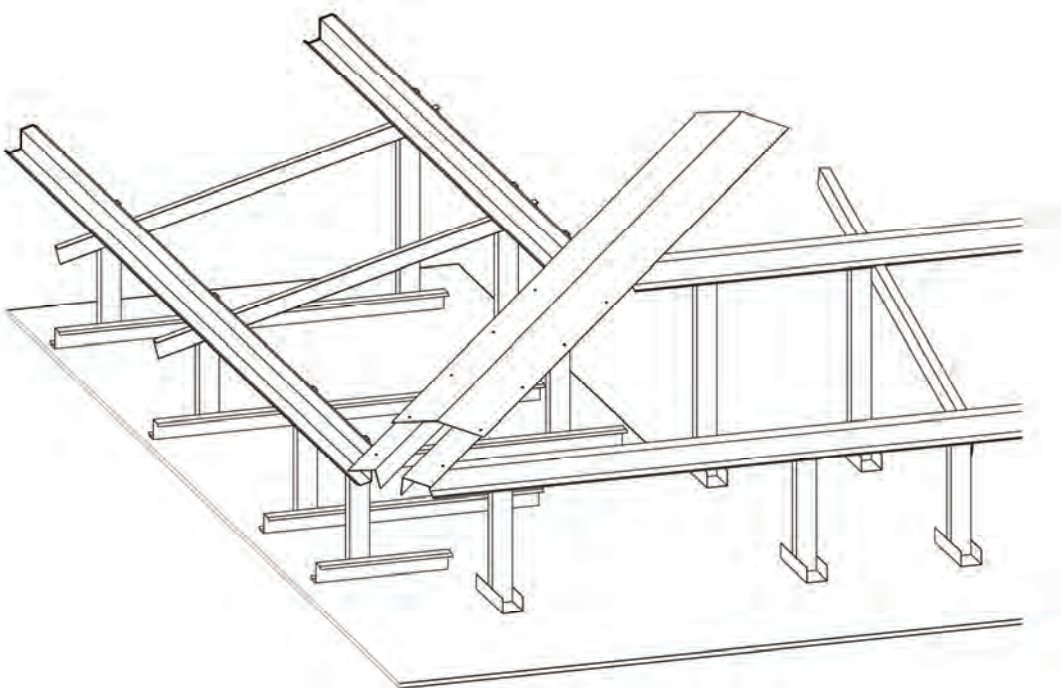


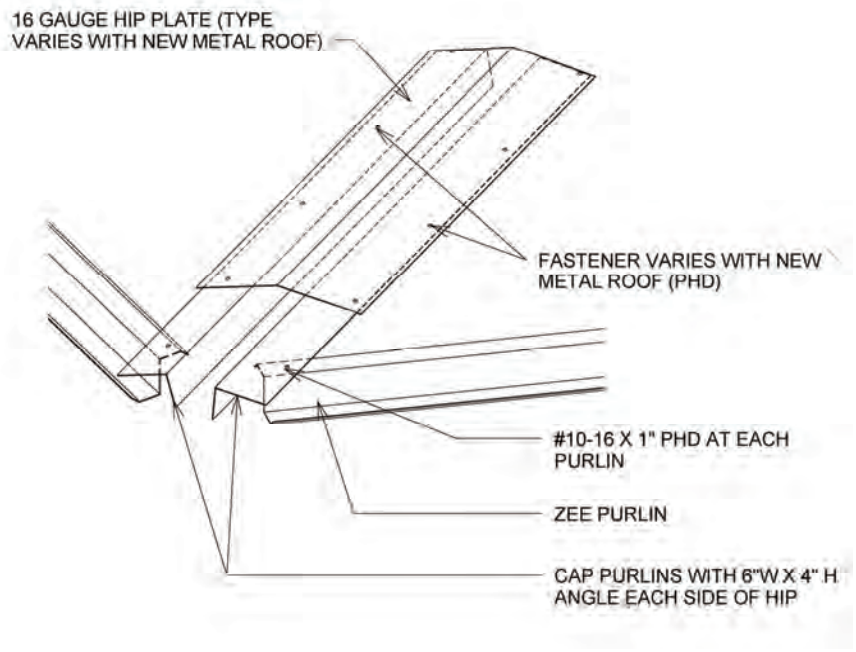


NOTES:

1. NOT FURNISHED BY METAL SALES
2. SHIM TO PROVIDE ADEQUATE BEARING SURFACE
3. FASTENER VARIES PER PANEL TYPE
4. SEE PANEL DETAILS FOR ATTACHMENT

metal sales manufacturing corporation	Date 5/15/2013	Variable Height Zee Purlin at High Eave





metal sales manufacturing corporation	Date 5/15/2013	Hip Framing